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The Director for Force Structure, Resource and Assessment, The Joint Staff

Director, Program Analysis and Evaluation, Office Secretary of Defense

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66th MORSS

Final Program & Book of Abstracts

Naval Postgraduate School,
Naval Support Activity Monterey Bay
and
US Army TRAC Monterey

Monterey, CA
23 - 25 June 1998

Theme:

Preparing for Military Operations Research in the 21st Century

Military Operations Research Society (MORS)
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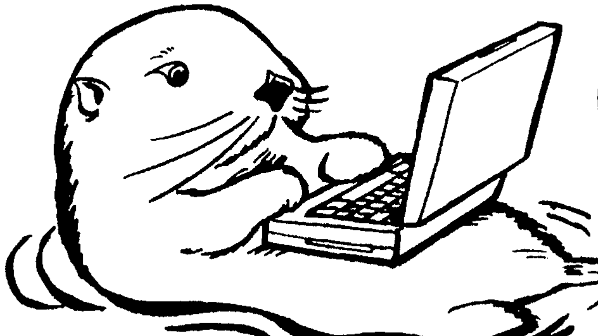

66th MORSS

Naval Postgraduate School

Get ready for next year's MORS
67th Symposium!!!!

US Military Academy

West Point, New York
22, 23, 24 June 1999

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This publication contains titles of presentations made at the 66th MORS Symposium (66th MORSS), along with names, addresses, phone and fax numbers and e-mail addresses of authors, if available. In addition, abstracts of presentations, which are Unclassified and Approved for Public Release, are included. Some abstracts are missing because they had not been cleared for public release at the time of publication.

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1966 - 1996

MEMORANDUM FOR: Deputy Under Secretary of the Army (Operations Research)
The Director, Assessment Division, Office Chief of Naval Operations
Director of Command and Control, Deputy Chief of Staff, Air and Space Operations, Headquarters USAF
Commanding General, Marine Corps Combat Development Command
The Director for Force Structure, Resource and Assessment, The Joint Staff
Deputy Director, Program Analysis and Evaluation, Office Secretary of Defense

FROM: Dennis R. Baer, President

SUBJECT: 66th Military Operations Research Society Symposium (66th MORSS)

DATE: 12 August 1998

1. Reference is made to Office of Naval Research Contract N00014-97-C-0096, dated 27 March 1997 as amended. Referenced contract requires that the Military Operations Research Society, *inter alia*, plan and execute the 66th Military Operations Research Society Symposium (66th MORSS). This is the report of that Symposium.

2. The 66th MORSS was held at the Naval Postgraduate School, Monterey California on 23 – 25 June 1998. The theme was *Preparing for Military Operations Research in the 21st Century*. Nearly 1,100 military operations research analysts, users of military operations research, allied disciplines and decision makers attended. The Keynote was delivered by DR William J. Perry, former Secretary of Defense. About 800 papers were presented in three Special Sessions, seven Composite Groups, 32 Working Groups and a Poster Session. Seven Tutorials on such diverse subjects as *Genetic Algorithms: Application and Theory* and *Blackhawk Down: An Account of the 1993 Mogadishu Firefight* were also presented. Two of the tutorials were half-day sessions presented the day before the start of the Symposium.

3. During the opening plenary session, several analysts were recognized for their outstanding work and contributions to the community. The David Rist Prize for the best paper submitted in response to a call for papers in 1997 was awarded to Dr. Paul H. Deitz and Michael W. Starks, Army Research Laboratory, Survivability/Lethality Analysis Directorate for their paper, *The Generation, Use, and Misuse of "PKs" in Vulnerability/Lethality Analysis*. The Richard Barchi Prize for the best paper presented at the 65th MORSS was presented to Arthur Brooks, The RAND Graduate School, Bart Bennett and Steve Bankes, the RAND Corporation

for their paper, *An Application of Exploratory Analysis: The Weapon Mix Problem.* These prize papers are included in this report (Inclosures 3 and 4, respectively). They will be submitted to the Editor of MORS' journal, *Military Operations Research,* for consideration for publication. Unclassified abstracts of these and other papers presented are on the MORS Web Page at www.mors.org. The prize papers will also be submitted to the Defense Technical Information Center to make them available to a larger audience. Articles in the MORS bulletin *PHALANX* will draw attention to these outstanding papers. The Vance R. Wanner Award for sustained achievement in Military Operations Research and contributions to the Military Operations Research Society was presented to General Larry D. Welch, Former Chief of Staff of the Air Force and current president of the Institute for Defense Analysis.

4. This report includes the following inclosures:

Inclosure 1	66th MORSS Attendance Statistics
Inclosure 2	*66th MORS Symposium Final Program & Book of Abstracts*
Inclosure 3	1997 David Rist Papers
Inclosure 4	65th MORSS Richard H. Barchi Papers
Inclosure 5	List of Attendees
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Inclousre 7	66th MORSS Membership Directory CD

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  RADM Pierce Johnson, Program Chair, 66th MORSS

- Host Welcome
  RADM **Robert Chaplin**, Superintendent, NPS

- Sponsor's Welcome
  Dr. **Susan Marquis**, N81D

- Keynote Address
  Dr. **William J. Perry,** Stanford University

- MORS Welcome and Ninth Annual Membership Meeting of the Military Operations Research Society
  Dr. **Jerry A. Kotchka,** President

  - 1998 State-of-the-Society Address

  - Presentations

    - Barchi Prize
    - Rist Prize
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  - How to get involved with MORS

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SPECIAL SESSION I

TUESDAY - 1530 – 1700 – 23 JUNE

Special Sessions Coordinators:
Edward Smyth, JHU/APL
CAPT Robert W. Eberth, N85X
MAJ Jerry Glasow, US Army CAA
LCDR Michelle Williams, CNO (N125)

Tuesday, 1530 - 1700.. **King Hall**

Leadership in an Information Dominant Battle

Coordinator and Moderator: Major **Jerry A. Glasow**, US Army CAA

History is replete with examples when skilled leadership has been decisive in combat. One critical aspect of that skill is a leader's ability to manage information. Recent and forthcoming advances in information technology promise to increase the amount of information available to leaders by orders of magnitude. However, there are natural limits to the amount of information which leaders can receive, judge, and act on. Analogous to the flesh and blood limits of pilots with respect to fighter aviation technology, there exits a "human baud rate" as a defining limitation for information technology. To realize the potential inherent in information technology, we must build information systems that recognize such human limitations and we must train our leaders to minimize the impact of those limitations. The purpose of this special session is to provide insight on the leadership challenges and opportunities of battlefield information technology to the operations research community – those who will design and build combat information systems and the training programs for their use. LTG **Paul J. Kern** will lead off with a short presentation on his experiences while he commanded the Army's Force 21 Division, the 4th Infantry Division, Mechanized. RADM **Robert N. Nutwell**, OPNAV Staff, and RADM **Robert Chaplin**, Superintendent NPS, will also make short presentations. This will be followed by a discussion period.

Tuesday, 1530 - 1700.. **G-109**

A Mini-Symposium Report: Warfare Analysis & Complexity

Chair: Dr. **Julian Palmore,** US Army CERL

The Mini-Symposium report will describe the history, planning and execution of "Warfare Analysis and Complexity" held at the Johns Hopkins University Applied Physics Lab in Columbia MD in September 1997. It will discuss events since the September meeting and the efforts of the working groups during the past year to come to grips with the concepts and applications of the new sciences to warfare analysis.

Tuesday, 1530 - 1700.. **G-102**

Mini-Symposium Reports:

QDR Analysis: Lessons Learned and Future Directions

Chairs: Mr. **Michael Leonard**, IDA, Mr. **James N. Bexfield**, FS, IDA and Dr. **Peter Sharfman**, The MITRE Corporation

The "Military Force Structure Review Act of 1996," which was part of the FY 97 Defense Authorization Act, required the Department of Defense to carry out a fundamental and comprehensive examination of America's defense needs from 1997 to 2015. This review included analysis of anticipated United States national security requirements, the defense strategy to meet these requirements, and the force structure, capabilities, and investments needed to implement this strategy. The legislation calls for similar reviews to be conducted every four years. Although the major conclusions of the QDR of necessity represent informed judgment by the most senior military and civilian officials in the DoD, the QDR process was supported in 1996-97 by a large body of military analysis. The analytical community will again be called upon to play a major supporting role for the QDR scheduled for 2001. The purpose of this mini-symposium was to help the Department prepare for this important event.

This briefing summarizes the key insights gained at the mini-symposium. It includes some background on the use of analysis in the 1997 QDR, the anticipated questions/issues in the next QDR, and identifies areas where there are opportunities for improvement. It concludes with a summary of actions in progress and a list of recommendations.

DoD Infrastructure: Why it is & What does it cost?

Chairs: **Daniel Barker**, AFSAA/SAQ and Dr. **Daniel Nussbaum**, Naval Center for Cost Analysis

The purpose of this mini-symposium was to identify unresolved issues, data, and processes that are needed to establish the requirements, and associated costs, for some test areas within the DoD infrastructure. The agenda for the three day unclassified mini-symposium contained a day devoted to invited speakers and two days for working groups to address specific aspects of the infrastructure. This overview will provide highlights of the briefings provided by the guest speakers on the first day and the results of each working group.

The invited speakers provided the following presentations and tutorial:

OSD/PA&E	Changes in the Infrastructure since 1989	Dave McNicol
USD(A&T)	Defense Agencies: Sizing what the customer needs?	Nancy Spruill
LMI	Re-engineering DoD's Infrastructure	John Christie
Tutorial	DWCF	Jeff Bennett
Army	Infrastructure Initiatives	Craig College
Navy & Marine Corps	Infrastructure Initiatives	Mark Mohler
Air Force	Infrastructure Initiatives	Jo MacMichael

The working groups covered the following topics:

Topic	Area	Chair	Co-Chair
Real Property Maintenance	Installation Support	Nancy Moore	Dennis Baer
Department-Wide Administration	Force Management	Mark Mohler	Col. Greg Parlier
Defense Information Infrastructure	Central C4I	Col. Bob Carr	Jackie Henningsen
Infrastructure overhead associated with developing military operators	Central Personnel	Don Cymrot	Col. Tom Allen
Process Model for Working Capital Fund Programming	DWCF group	Jeff Bennett	Greg Parnell Gregg Burgess

Tuesday, 1530 - 1700...**I-122**

Rist and Barchi Prize Paper Session

Prize Paper Coordinator: ***James B. Duff**, PRC, Inc.,*
Rist Prize Coordinator: ***Howard Whitley**, USA CAA*
Barchi Prize Coordinator: *Col **Kenneth Konwin**, DMSO*

The **Rist** and **Barchi Prizes** will be announced and awarded in the opening ceremonies of the 66th MORSS. This special session will provide the opportunity for the prize winners to present their winning papers. The Committee Chairs will discuss the prize process and pertinent points from select non-winning papers.

Barchi Prize Paper
An Application of Exploratory Analysis: The Weapon Mix Problem

Arthur Brooks, The RAND Graduate School
Bart Bennett and **Steve Bankes,** The RAND Corporation
1700 Main Street
PO Box 2138
Santa Monica CA 90407-2138
310-393-0411 ext 6668 Fax: 310-451-7067

Over the last several years, a new approach to model-based analysis has been developed at RAND. This approach, exploratory analysis, greatly expands on traditional analytic approaches in order to enhance understanding of complex problems, provide a wider range of information for decision makers, improve comparison between alternative models, and thereby enable greater comprehension of policy options. This paper reviews the methodology of exploratory analysis and its advantages over traditional analysis in the context of a search for the preferred weapon mix. We begin by walking through a traditional analytic approach and showing the kinds of results that are often observed. We then perform exploratory analysis, requiring a large number of computational experiments-on the same problem, and show that it provides more information and keener insights than we originally obtained. We continue by describing exploratory analysis more generally, and demonstrate its benefits to the decision maker and the analyst. We also discuss what is required for its routine use.

Rist Prize Paper

The Generation, Use, and Misuse of "PKs" in Vulnerability/Lethality Analyses

Dr. **Paul H. Deitz** and Dr. **Michael W. Starks**
Survivability/Lethality Analysis Directorate
Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5068

Beginning with World War II and its aftermath, the area of ballistic vulnerability/lethality (V/L) was first defined as a specific discipline within the field of ballistics. As the field developed, various practices and metrics emerged. In some cases metrics were developed that were abstractly useful but bore no direct relationship to field observables. In the last decade, as issues concerning Live-Fire strategies have gained importance, increased attention has been focused on V/L with the intent of bringing greater rigor and clarity to the discipline. In part this effort has taken the form of defining a *V/L Taxonomy* which is a method of decomposing a series of concatenated complex processes into separable, less-complex operations, each with certain specifiable properties and relationships.

Using the Taxonomy, this paper describes how the most commonly used V/L metrics are a function of platform *aggregate damage*, reduced platform *capability,* and reduced platform *military utility*. We show that these three distinct and separable classes of metrics are linked by operators that are multivariate, stochastic, and nonlinear. We also show that it is useful to form probability distributions with respect to initial and boundary conditions in order to characterize damage, capability, and utility. Many defense community studies ignore these distinctions to the detriment of fundamental clarity. Examples are given and potential remedies described.

SPECIAL SESSION 2

WEDNESDAY – 1530 – 1700 - 24 JUNE

Wednesday, 1530 - 1700.. **King Hall**

Validation Methodologies

Coordinator: LCDR Michele Williams, CNO (N122)
Panelists include: Dr. Dale K. Pace, JHU/APL
Capt Robert W. Eberth, MCCDC
Maj. Suzanne Beers, HQ/AFOTEC
Panelists include: Michelle Kilikauskas, (JASA)
Huey P. Allen, Jr., The Boeing Company
Moderator: Priscilla A. Glasow, The Mitre Corporation

Performing Verification, Validation, and Accreditation (VV&A) on both legacy and developmental systems presents a significant challenge for the analyst. Much has been written regarding procedures and methodologies to accomplish VV&A efforts. This Special Session will focus on the presentation of case studies of past and current VV&A activities in order to provide the analyst with recommendations and suggestions for use in future VV&A efforts.

Panelists will draw from examples of VV&A activities from programs such as Wargame 2000, the Joint Tactical Simulation, the Joint Defensive Planner (JDP), Joint Strike Fighter, and various mine warfare programs. Issues such as the validation of conceptual models in a large human in control (HIC) command and control (C2) simulations, the application of VV&A to operational systems with embedded M&S, and the use of Technical Validity Assessment (TVA) will be discussed. The major emphasis of the panel discussion will concentrate on the presentation of lessons learned gleaned from these VV& A experiences.

Wednesday, 1530 - 1700.. **G-109**

A Mini-Symposium Report: Simulation Technology (SIMTECH) 2007

Dr. **Stuart Starr**, MITRE

Ten years ago, MORS sponsored a series of three workshops on simulation technology, entitled SIMTECH 97. In December 1997, the first of two new workshops on simulation technology was convened. The objectives of this new workshop were two-fold: to look to the past, to review and assess the findings and recommendations that were made by the participants at SIMTECH 97, and drawing on the lessons learned from that experience, to look ten years into the future. The participants were charged with identifying and prioritizing the future needs of users of military M&S in the areas of education & training, acquisition, and analysis. In addition, they were tasked with assessing the probable evolution of M&S technology over the next decade.

This session will begin with a review of the major findings and recommendations that emerged from both the retrospective and future looking panels. In addition, selected chairs of these panels will provide more in-depth perspectives on their deliberations. The presenters will then convene as a panel to field questions from the audience and to discuss their plans for the second SIMTECH 2007 workshop. That workshop will be held in the Washington DC area, 18 - 20 August, to identify technologies that have the potential to satisfy identified user shortfalls and to recommend actions to ameliorate them.

Wednesday, 1530 - 1700

Junior/Senior Analyst Session

Coordinators: ***Howard Whitley**, US Army CAA, **Lana McGlynn**, AMSO, and **Eugene P. Visco**, FS, Consultant*

Session 1 .... **G-115**

*Mr. **Jim Johnson**, OSD/PA&E – Deputy Director for Theater Assessments & Planning*
*Dr. **Jerome Bracken**, Army & Defense Consultant, Adjunct Professor, Yale University*

Session 2 .... **G-118**

*LTG **David K. Heebner**, Assistant Vice Chief of Staff, Headquarters, Department of the Army*
*Dr. **Seth Bonder**, FS, President, Vector Research, Inc*

Session 3 .... **G-130**

*LTG **David L. Vesely**, Assistant Vice Chief of Staff, Headquarters, Department of the Air Force*
*Ms. **Natalie Crawford**, RAND, Vice President & Director, Project Air Force*

Session 4 .... **G-113**

*VADM **Pat Tracey**, Director of Naval Training, Office of the CNO*
*Dr. **Susan Marquis**, Associate Director, Assessment Division, Office of the CNO*

Session 5 .... **G-114**

*MajGen **Patrick G. Howard**, Deputy CG, MCCDC*
*Dr. **Al Brandstein**, Technical Advisor, Studies & Analysis, MCCDC*

SPECIAL SESSION 3

THURSDAY – 1530 - 1700 - 25 JUNE

Thursday, 1530 - 1700 .... **King Hall**

Navy Flag Panel:

Preparing Today's Operations Research Analysts for the Next Century

Coordinator: ***Ted Smyth**, JHU/APL and CAPT **Bob Eberth**, OPNAV (N85)*
Moderator: *RADM **Pierce Johnson**, Program Chair, 66th MORSS*

Invited panelists include VADM **Conrad C. Lautenbacher**, VADM **Daniel T. Oliver**, VADM **Patricia A. Tracey** and RADM **Robert Nutwell**. All of these invited officers have either an operations research background and/or considerable experience and knowledge of the contributions provided by the operations analysis community in support of both operational and program requirements. Their goal is to relate their experiences as an analyst, a supervisor or analysts, and a military commander to discuss what they believe the Operations Research community needs to do today to prepare for the next century.

Thursday, 1530 - 1700 .... **G-102**

Education Colloquium Session

Coordinator: Col **Kenneth Konwin,** DMSO

Education Colloquium 98, was held at the ANSER Corporation Conference Facility on April 21-22, 1998, with the theme "Sharpening the Saw -- Maintaining Professional O.R. Readiness and Relevance". This event debuted a "new look" colloquium emphasizing life long Professional Development activities and was offered as a "no registration fee" event to encourage participation beyond the traditional education colloquium audience. The first day included reflections from Jim Bexfield, MORS Fellow, on what skills and professional qualities have served him well on some of the more demanding studies he's had the opportunity to work on. This event was followed by four very fine 90 minute tutorials that focused on more current "hot topic" O.R. analysis techniques. The second day included a morning of 45 minute presentations by more junior analysts who were nominated as "up and coming" by their MORS Sponsor organization reps. The young analysts in the gathering were then polled to assess what they found most and least relevant in their O.R. education. The afternoon continued the theme with a short retrospective of the USAFA O.R. curriculum comparing the O.R. majors during 1988 and 1998. The afternoon continued with brief overviews of some more non-traditional curriculums from private universities and the new MOVES curriculum of the Naval Postgraduate School. Finally, representatives of the Services and Industry spoke of professional development strategies during which it was discovered that there are similar structural challenges in the O.R. analyst work force that will need to be addressed in all agencies utilizing O.R. analysts. The "new look" was highly praised by the participants and will likely be offered in a similar format next year. Supervisors of O.R. analysts are encouraged to plan now to send several junior analysts next year to benefit from this "high professional return on organizational investment" opportunity. This session will discuss the outcomes and future of the Education Colloquium.

TUTORIALS

MONDAY, 1300 – 1700

TUESDAY, WEDNESDAY, THURSDAY - 1215 – 1315

Tutorial Coordinators:
Dr. **Yupo Chan,** AFIT/ENS
MAJ **Jean McGinnis,** DAAR/PAE
LCDR **Shawn Callahan**, OPNAV N81

Monday, 1300 - 1700.. **G-109**

Ready, Fire, Aim – Operations Research in Spreadsheets

Sam L. Savage, Stanford University

Traditional field artillery is set up, aimed at a large stationary target, and finally fired. To hit small moving targets, tracer-firing, automatic weaponry was developed, which is fired first and then aimed. A parallel holds between large traditional application of operations research and small analytical models on personal computers. This tutorial covers interactive applications of simulation, forecasting, decision analysis and optimization in the spreadsheet environment. Detailed topics to be covered include: Modeling in Spreadsheets, Forecasting, Simulation, Markov Chains, Decision Trees, Linear Programming, Integer Programming, Nonlinear Programming and Stochastic Optimization.

Monday, 1300 - 1700.. **G-102**

Genetic Algorithms: Application and Theory

LTC **John A Marin**, U S Military Academy

Genetic algorithms are a class of probabilistic algorithms that simulate nature's process of natural selection in which an evaluation function is used to determine which members of the population are "good" or "bad". Genetic algorithms are simple to understand, easy to code, robust, and appear to work on a large class of interesting problems for which no reasonably fast algorithms exist. For example, genetic algorithms have been applied to scheduling, routing, transportation, optimal control, and variable reduction problems. Genetic algorithms are domain independent, and are naturally massively parallel. Also, genetic algorithms generally explore more of the solution space than other heuristic search methods because genetic algorithms maintain and manipulate a population of possible solutions rather than altering one solution at a time. This tutorial will address the standard implementation procedures of genetic algorithms, such as: genetically representing potential solutions, genetic operators that alter the composition of children during reproduction, and assigning values for various parameters that a genetic algorithm employs. Additionally, this tutorial will address asexual reproduction techniques sometimes referred to as evolutionary programs. Several common problem types, such as the traveling salesperson problem and nonlinear transportation problem, will be used to illustrate how the solution methodologies work. Applications addressing genetic algorithms in military command and control and simulation will be presented. Advanced topics, including hybrid systems involving genetic algorithms used in variable reduction, data mining, and neural network topology selection, will also be presented.

Tuesday, 1215 - 1315.. **G-102**

Littoral Undersea Warfare/Battle Space Realism for Simulation

Mr. **Tom Little**, Navy's Sea-based Weapons and Advanced Tactics School

Government and industry leaders need to be aware of critical meteorology/oceanography (METOC) factors that impact USW operations so they can incorporate these environmental factors into future simulations. A realistic simulated environment is a critical training tool that will enable USW warriors to dominate the complex littoral battle space. Unfortunately, current fleet wargame systems and weapon system trainers do not provide a realistic battle space in high priority operational areas. A joint training architecture for the 21st Century will include networked trainers that require the capability of including acoustic and non-acoustic simulations/stimulations that utilize high-fidelity data bases. The latest METOC data base versions should be available over the SIPRNET to standardize the battle space prior to the start of a coordinated simulation. Once incorporated, they would provide the warrior with a fused picture of the battle space and the ability to respond, coordinate and meet horizontally, vertically, and temporally to fulfill mission rehearsal objectives. Battle space realism for networked simulations will ultimately result in increased Measures of Effectiveness (MOE), Measures of Performance (MOP) and ultimately increase overall fleet readiness. To gain an appreciation of environmental factors that impact battle space dominance during a USW mission, tactical lessons learned during littoral exercises will be discussed. These exercises were impacted by environmental factors that varied from hour-to-hour, day-to-day and season-to-season. These changes significantly impacted acoustic and non-acoustic detection ranges and numbers of assets required to accomplish the mission. Additionally, a vision for a joint training architecture for the 21st Century will be discussed.

Tuesday and Wednesday, 1215 - 1315.. **G-118**

You're a Working Group Chair? Congratulations! What do you do?

CDR **Kirk Michealson**, Office of the Secretary of Defense

Have your ever heard these words and didn't know what to do? Or, are you apprehensive about volunteering as a Composite group or Working Group Chair because you don't know what to do or what is expected? This tutorial has evolved over the years just as the answer to these questions and any other questions you might have had (but were afraid to ask) about running a high-quality MORS Working group. During the presentation, highlight of the chair's duties and responsibilities will be discussed, including team composition, paper solicitations, session development, speaker involvement, symposium preparation, and finally, putting it all together. This one's "a must" for MORS future or prospective composite group or working group chairs and co-chairs.

Tuesday, Wednesday and Thursday, 1215 - 1315.. **G-109**

Marketing Operations Research, Session 1, 2 and 3

Dr. **Greg Parnell,** FS, Virginia Commonwealth University

Marketing of operations research/management science (OR/MS) is a key skill that practitioners (both consultants or academic) must learn to obtain the opportunity to help decision-makers or to obtain research sponsors. Unfortunately, very little of our formal education includes important OR/MS marketing concepts and communications skills. Most of us have learned by experience. The purpose of this tutorial to provide a framework for understanding the basic concepts for effective marketing of operations research/management science to decision-makers and research sponsors. The instructor will draw on his over 25 years of experience as a decision-maker (government), consultant (government and industry), and academic (government and public university).

Tuesday, Wednesday, and Thursday, 1215 - 1315.. **I-122**

Introduction to Bayesian Networks, Session 1, 2 and 3

Dr. **Joseph A. Tatman**, TASC; Dr. **Dennis M. Buede**, George Mason University; Mr. **Terry A. Bresnick**, Innovative Decision Analysis

Bayesian networks are a framework for representing and analyzing models involving uncertainty. They were developed from a cross-fertilization of ideas between decision analysis, artificial intelligence, and statistics. Theoretical advances and the availability of software tools for analyzing Bayesian nets has sparked a flurry of applications in broadly different areas including medical diagnostics, intelligent decision aids, data fusion, automated free text understanding, and 3-D feature recognition to name but a few. This three day tutorial will present the basic concepts of Bayesian nets and demonstrate the broad applicability of this robust modeling paradigm. The first day will focus on basic constructs and motivating examples and demonstrations. The second day will address operations on Bayesian nets and propagation algorithms for analysis. Issues in model construction and assessment will also be covered. The third day will be devoted to special topics such as learning, continuous random variables, and review of available Bayesian net software.

****Special Unclassified Tutorial****

Wednesday, 1215 - 1315.. **Mechanical Engineering Auditorium**

Blackhawk Down: An Account of the October 1993 Mogadishu Firefight

Mr. **Mark L Bowden,** The Philadelphia Inquirer

In October 1993 a group of US Army Rangers and Delta soldiers attempted to seize Somali clan leaders in a Mogadishu hotel as a part of the ongoing OOTW operation being conducted in that country by US and multinational forces. The operation went badly wrong almost from the beginning, resulting in two US helicopters being shot down, and a intense firefight between the US special operations forces and armed Somalis that lasted over 24 hours and left 18 US dead. The operation culminated in a multinational rescue convoy led by infantry forces from the US 10th Mountain Division. This presentation is a description of the operation, some insights as to why it went so wrong, and the research that uncovered the minute-by-minute activities of the forces involved. In the best tradition of BG S.L.A. Marshall, an early Army historian and analyst, Mr. Bowden interviewed dozens of the soldiers and Somalis involved in the action, and pieced together a comprehensive history of the firefight from the stories of the soldiers involved. He was allowed access to government archives of official accounts of the battle, as well as video and audio tapes of the action, and visited the scene in Mogadishu while researching the piece. Mr. Bowden has put together a website on the Internet which includes not only the narrative, but video and audio clips from the action integrated into the narrative. This tutorial presents the history of the battle, and the research and analysis that was done to determine what truly happened. It covers many of the aspects of current special operations as well as OOTW missions, and is presented to acquaint the analytical audience with some of the characteristics of these diverse and difficult operations.

COMPOSITE GROUP A – STRATEGIC & DEFENSE
WORKING GROUPS 1, 2, 3, & 4
CHAIR: MICHAEL O. KIERZEWSKI, OPTIMETRICS
TUESDAY, 1030 – 1200 .... I-122

Aspects of Russian-American Stability Issues with Reduced Strategic Forces

Frederic S. Nyland
US Arms Control & Disarmament Agency
320 21st Street NW
Washington DC 20451
218-751-3342

This paper provides a discussion and examination of four possible sets of strategic nuclear force structures beyond START II that might set terms for future arms reduction treaties between the US and Russia. Warhead limits of 2500 (proposed START III), 1500, 800, and 400 are evaluated in terms of their potential stability problems. The measures used in this analysis include first strike stability, the effects of a national ballistic missile defense, and one indicator of geopolitical stability (the non-alert rate of nuclear systems). Assumed force structures and postures illustrate general methods of analyzing the impacts of reduction in strategic nuclear arsenals.

The Defense Science Board 1997 Summer Study Task Force on DoD Responses to Transnational Threats

General **Larry Welch** (USAF, retired)
President
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Transnational actors have three advantages: 1) they can have ready access to weapons of mass destruction; 2) we cannot easily deter them because they have no homeland; and 3) they respect no boundaries, whether political, organizational, legal or moral. Further, warning may be short and attribution may be slow or ambiguous. Since the United States is now the dominant military force in the world, potential adversaries will be driven to asymmetric strategies to meet their objectives. As such, transnational threats represent an important national security problem. General Welch was the co-chairman of the 1997 Defense Science Board Task Force that studied this important class of threats. His presentation will summarize the findings and recommendations developed by this Task Force.

COMPOSITE GROUP B – SPACE/C4ISR
WORKING GROUPS 5, 6, 7, 8, 9, 10, 11
CHAIR: DR. JOHN A. BATTILEGA, SAIC
TUESDAY, 1330 – 1500 .... G-109

Information Operations Research in the 21st Century

One of the major challenges of military operations research for the 21st Century will be properly dealing with information operations(IO). Within the last several years, IO has been a developing concept which has now crystallized in many respects, but may be still in a state of flux in others. Within the MORS context, IO encompasses five of the seven Group B Working Group topical areas; more importantly, it also reaches out into all of the combat areas distributed throughout the other MORS working groups.

This session will feature two talks, and a discussant. **LTC Steve Mahoney**, OSD(C3I)/IO, will describe the new *DoD IO Master Plan,* which was approved on 26 March, 1998. He will discuss the overall master plan, and will emphasize the modeling and simulation portion. **Dr. John Battilega**, SAIC, will then discuss some of the complexities of military OR as it pertains to IO in a talk entitled *Military Information Operations Research: Towards Untangling the Gordian Knot.* **Dr. Paul Davis** of the RAND Corporation will serve as a discussant for both talks. The last portion of the session will be reserved for questions and floor discussion.

COMPOSITE GROUP C – JOINT WARFARE
WORKING GROUPS 12, 13, 14, 15, 16, 17
CHAIR: DENIS T. CLEMENTS, GRC INTERNATIONAL

WEDNESDAY, 0830 – 1000 ....G-109
WEDNESDAY, 1030 – 1200 ....G-109

Wednesday, 0830 - 1000
A Methodology for Future Force Structure Analysis

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Abstract unavailable at printing.

Wednesday, 1030 - 1200
Joint Warfare System (JWARS) Overview

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The Joint Warfare System (JWARS) will be a state-of-the-art, closed-form, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the Combatant Commanders, Joint Staff, Services, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide an overview of the JWARS project. It will provide a discussion on the background of JWARS, how oversight of the program is conducted, an overview of the requirements process, some of the development techniques and a quick look at the evaluation process. Presently the JWARS project is one year into a four year development process. This briefing will be an updated briefing of the JWARS status and provide material for follow-on panel discussion as well as other Working Group forums.

COMPOSITE GROUP D — RESOURCES
WORKING GROUPS 18, 19, 20
CHAIR: ALAN R. CUNNINGHAM, US ARMY TRADOC ANALYSIS CENTER

TUESDAY, 1030 – 1200 ....G-109

Solving Generalized Assignment Problems Using Explicit Constraint Branching

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The Generalized Assignment Problem (GAP) is a Binary Integer Programming model that can be used to model problems with Army and Joint application. Such applications include the scheduling of scarce resources to accomplish a mission, such as the

deployment by sea of the equipment of CONUS-based units to Desert Storm, and scheduling the intra-theater delivery of scarce logistics such as fuel or ammunition. Because even modest-sized GAPs (200 variables) can be difficult to in a reasonable amount of computing time, enhanced solution techniques are required. This paper introduces explicit-constraint branching (ECB), a new technique that has dramatically decreased solution times for the GAP. This technique has also been used with success on other IPs and MIPs.

Calculating Requirements for Deployments and Logistical Resources (CARDEALR)

LTC **Patrick J. DuBois** (USA)
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This paper discusses a self-contained decision support system (DSS) developed in support of engaged forces in the SSC JOINT ENDEAVOR in Bosnia and Herzegovina. Due to the eminent danger experienced by Stabilization Force (SFOR) soldiers in Bosnia, the US Army instituted a policy to rotate units every eight to ten months. During the rotation, key nodes (base camps, intermediate staging base, rear staging base) in the flow of troops approach or exceed personnel and vehicle capacity. In anticipation of the Oct - Nov 97 rotation of the 1st ID (Fwd) and the 1st AD, the 1st ID (Fwd) through USAREUR requested CAA to automate existing redeployment models to allow for the more efficient use of division staff personnel.

The Calculating Requirements for Deployment and Logistical Resources (CARDEALR) Quick Reaction Analysis (QRA) is a model (given changes in deployment schedule) that: instantaneously tracked the movement of forces in/out of Bosnia; instantaneously highlighted key nodes (base camps, ISB, RSB) that exceed capacity; provide instantaneous staff coordination; allow for "what if" scenarios to allow the staff to identify and solve problems before they occur; and is user friendly. In Sep 97, CAA developed, delivered, demonstrated, and trained division personnel on the use of the model that contained the above attributes on site in Bosnia and Herzegovina. The division G3 plans section immediately incorporated the model in the planning and executing phase of the redeployment operation.

COMPOSITE GROUP E – READINESS/TRAINING

WORKING GROUPS 21, 22 & 23

CHAIR: DR. PATRICK D. ALLEN, CUBIC APPLICATIONS, INC.

Making OR Relevant to 21st Century Decision Making

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What are the big 21st Century decisions the US will face? What tools are currently available to support decision makers make informed decisions? What are the operations research products needed to help make these decisions? What are the tools needed to articulate and express the results to a wide range of audiences, especially those with little analytic background? What are the OR tools needed to produce this range of decision support products?

This talk presents observations of the inadequacies of current OR tools to support decision making in the face of 21st century realities. Experiences of the Quadrennial Defense Review and during quick-response contingencies demonstrates the need for a new set of OR tools to support decision makers in making informed decisions in this new environment. One big class of problems is when and how to use forces, and how to visualize the tradeoffs associated with the various decisions. It's time to pull some of these problems out of the "too hard to do" box, and place them in the category of the "doable." The challenge to the OR community is to develop the tools relevant to the decisions that must be made, and not to develop more tools for the problems we already know how to solve.

Defense Program Projection (DPP) - Robust Analysis of OSD Programming

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The Defense Program Projection is a long-term projection of DoD programs based on the President's Budge: FYDP and other official documents. It is the joint venture of OD PA&E and USD(A) API to meet Defense Management Review requirement for "...a rough, 20-year "road map" of the modernization needs and investment plans of DoD, projecting the impact of the Program Planning Objectives, and of additional modernization or replacement of major systems (e.g.. ships, aircraft, tanks and satellites) expected by the Military Departments and Defense Agencies, against realistic levels of future funding."

The projection assesses the consequences for forces and resources of the Future Year Defense Plan (FYDP) twelve years beyond the current six-year program plan, currently out to FY 2015. The DPP includes high and low excursions as well as an analysis and characterization of both the near- and far-term resource and force structure risks associated with the current FYDP. DPP data and analyses have been used in the past in supporting the Bottom Up Review (BUR), the Quadrennial Defense Review (QDR). the National Defense Panel (NDP). and several Program Reviews.

The DPP adopts several measures of merit to assess the long-term adequacy and executability of the FYDP. These measures include average fleet age, age distribution, projected procurement vice steady-state needs, and projected resource needs versus current resources requested and appropriated. This presentation provides a top-level overview of the FY 1999 DPP.

Simulation Based Acquisition, An Industry Perspective

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The use of Modeling and Simulation (M&S) in the design and fielding of U.S. military equipment has dramatically increased as information technologies have evolved over the past 30 years. M&S has been used to conduct complex evaluations of new systems and alternatives, in support of testing and evaluating new systems, and in the development of training systems and environments. But the use of simulation across the full spectrum of the acquisition life cycle has been neither consistent nor coordinated. There are many phases that have seen little benefit from improved simulation or analysis techniques. More importantly, there has been very little coordination or syntheses in the use of analysis and simulation tools across acquisition phases. This entrepreneurial and experimental use of M&S technology was consistent with the dynamic and explosive development of computing equipment, software and applications. But we have entered a new phase of the information technology revolution and now have the experience base and system concepts to permit a more orderly approach in the use of M&S to bring broader efficiencies to the DoD acquisition process. In many ways, SBA can be an implementing engine for significant acquisition reform in a severely constrained budget environment. Indeed, many believe that if we fail to take this step, we will miss the opportunity to bring revolutionary efficiencies in recapitalizing/modernizing DoD equipment and systems. The application of M&S to address this opportunity has been named Simulation Based Acquisition (SBA).

A DoD/industry team has been assessing SBA concepts and requirements since July 1997, and an SBA workshop is being held in March 1998. This paper will define SBA and provide the terms of reference and discuss industry's concerns, concepts and plans in the implementation of an efficient and effective DoD SBA environment.

COMPOSITE GROUP G — ADVANCES IN MILITARY OPERATIONS RESEARCH
WORKING GROUPS 29, 30, 31, 32
CHAIR: LTC DAVID W. HUTCHISON, OCSA-PAED
THURSDAY, 1030 – 1200 ....MECH ENGINEERING AUDITORIUM

The Revolution in Analytical Affairs
Briefer: **Daniel J. Shedlowski**, SES, Technical Director, US Army Concepts Analysis Agency

This presentation discusses the results of an initiative to evaluate how the Army analysis community should change to improve its capability to meet the present and future analytical demands of its analysis customers. The catalyst for this project was the keynote address by the Army Assistant Vice Chief of Staff, LTG David Heebner, at the November 1997 Army Operations Research Symposium. LTG Heebner highlighted the ongoing revolution in business and military affairs and questioned whether there is or should be a corresponding revolution in analytical affairs. To answer LTG Heebner's inquiry, general officer level Army Commanders and heads of major staff elements were interviewed to develop a description of customer analysis demands. Major post cold war changes in the analysis community were identified. Based on this information along with an understanding of the underpinnings of current counterpart revolutionary changes in government, military and commercial sectors, a proposal was developed for a revolutionary change in the Army analysis community—a proposal that is distinctly customer focused. This session will discuss this proposed revolutionary change along with other supporting initiatives.

POSTER SESSION
CLUB DEL MONTE BALLROOM – HERRMANN HALL
TUESDAY – MIXER – 1700 – 1900 -- 23 JUNE
WEDNESDAY – LUNCH -- 1200 – 1330 – 24 JUNE

Poster Session Coordinators:
Eleanor Schroeder, Naval Oceanographic Office
Dr. **Ernest Montagne**, BDM and **Bill Dunn**, AMSO

The 66th MORSS Poster Session is designed to facilitate presentations, demonstrations, and displays—graphical, computer assisted, or combined—by selected personnel from all components of the military services, civilian and military, and their supporting consultants or contractors.

The Poster Session is based on several key objectives. 1) To increase the opportunity for attendees to view projects, demonstrations, and results of studies. 2) To provide an alternate vehicle (in addition to WG sessions) for presenters to display, discuss and present their projects or results.

After Action Review System on Unix and Windows NT

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Approved abstract unavailable at printing.

AMSAA Support to Simulation-Based Acquistion (SBA)

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AMSAA display exhibit of efforts in support of Analysis for the 21st Century Army, specifically in support of simulation based acquisition. In particular, the AMSAA display highlights AMSAA's capabilities in supporting SBA with systems analysis throughout the materiel life cycle. Specific AMSAA examples were given of analyses using modeling and simulation (M&S) in support of Advanced Technical Demonstrations (ATDs) / Advanced Concept Technical demonstrations (ACTDs); concept analyses; investment strategy analyses; Analysis of Alternatives; Cost as an Independent Variable (CAIV); performance analyses; M&S development; verification, validation and accreditation (VV&A); reliability engineering / physics of failure (PoF); wholesale logistics analyses; retail logistics analyses (including provisioning and level of repair analyses); industrial base analyses; war reserve analyses; rapid manufacturing; and force projection analyses.

An Interactive Demonstration of the Electronic Combat Data Exchange (ECDATX) Data Sharing Web Interface

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This Unclassified ECDATX poster presentation will demonstrate the application of Web interfaces to support the sharing of engineering and test data on secure networks. The Web server architecture uses hypertext links to engineering and test data, as well as archived CD-ROMs available through the on-line CD-ROM Juke Box. The interactive presentation will demonstrate the application of Web technology to support the access, viewing and analysis.

The operational implementation of the ECDATX data sharing initiative will be addressed in a paper in WG9. The ECDATX architecture of distributed data servers using Web technologies has provided both local and remote users near-real-time to access Electronic Attack (EA) engineering and test data collected ruing Performance Characterization Analyses conducted at Eglin AFB, FL and other locations.

The architectural design and implementation were addressed in a 65th MORS Technical Paper describing the development and evaluation of the ECDATX data sharing concept and architecture. Since the successful evaluation of ECDATX in supporting the April 97 MOBCAP EAST PCA, ECDATX has provided continuous data sharing support for PCAs performed at Eglin AFB and other locations during the last year.

Army Standards Development Process

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Standardization of the Army's Model and Simulation (M&S) processes is a vital step toward achieving the economies, efficiencies, and technological potential M&S represents. Through standards, the Army> '> s M&S community shares techniques, procedures, processes, and applications. It builds on the work of others and advances the art and science of M&S in tandem with technological advances. Thus standards development is an iterative and consensus based process. This ongoing process consists of 18 standards categories plus, the web based, Standards Nomination and Approval Process (SNAP) and the Army Standards Repository System (ASTARS).

Blackhawk Down: An Account of the October 1993 Mogadishu Firefight

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In October 1993 a group of US Army Rangers and Delta soldiers attempted to seize Somali clan leaders in a Mogadishu hotel as a part of the ongoing OOTW operation being conducted in that country by US and multinational forces. The operation went badly wrong almost from the beginning, resulting in two US helicopters being shot down, and a intense firefight between the US special operations forces and armed Somalis that lasted over 24 hours and left 18 US dead. The operation culminated in a multinational rescue convoy led by infantry forces from the US 10th Mountain Division. This presentation is a description of the operation, some insights as to why it went so wrong, and the research that uncovered the minute-by-minute activities of the forces involved. In the best tradition of BG S.L.A. Marshall, an early Army historian and analyst, Mr. Bowden interviewed dozens of the soldiers and Somalis involved in the action, and pieced together a comprehensive history of the firefight from the stories of the soldiers involved. He was allowed access to government archives of official accounts of the battle, as well as video and audio tapes of the action, and visited the scene in Mogadishu while researching the piece. Mr. Bowden has put together a website on the Internet which includes not only the narrative, but video and audio clips from the action integrated into the narrative. This tutorial presents the history of the battle, and the research and analysis that was done to determine what truly happened. It covers many of the aspects of current special operations as well as OOTW missions, and is presented to acquaint the analytical audience with some of the characteristics of these diverse and difficult operations.

Conference Scheduling and Location Selection

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A recurrent reason for Federal employee travel is to attend professional conferences or development training. The location of the conference or training site is often an arbitrary decision with little regard for travel cost. We developed a methodology to evaluate relevant travel costs and return the least expensive conference site given over 260 cities in the US with Government contracted airfares. This schema involves a new use of Dykstra's algorithm modified for non-capacitated shortest path network optimization as well as the computation of inter-airport distances using latitude and longitude data. This demonstration introduces a program called OffSite which optimizes the selection of collective training events or conferences where people need to come together from geographically dispersed locations. OffSite requires the meeting or conference planners to input a list of origin cities for conference participants and then it determines the least cost location for hosting the conference. Additionally, OffSite is flexible enough to allow planners to choose a preferred destination. This user can also restrict the search for meeting venues to origin locations should an organizer wish to have one of the meeting's participants "host" the conference.

Decision Support Center Analytic Infrastructure Demonstration

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The Joint C4ISR Decision Support Center was tasked by the VCJCS, the USD(A&T), and the ASD(C3I) to create an analytic infrastructure to support members of the C4ISR community in conducting analysis of C4ISR issues. The objective of the infrastructure is to assist study sponsors and organizations to identify and leverage completed and on-going studies and modeling and simulation (M&S) tools in order to improve overall study quality, reduce perceived study duplication and cost, and foster collaboration.

A prototype version of the infrastructure, focusing on C4ISR studies, went on line on the World-Wide Web on 26 March 1997. The Studies Database (SDB) has since been updated at monthly intervals to increase both its data content and functionality. The SDB is also accessible on the SIPRNET and the Pentagon's C3I SCI/B LAN. In January 1998, we began a transition to a new and improved database structure. The on-line database still contains the former studies database, which is essentially unchanged except that data on studies continues to be added and the look and feel has been modified. To this has been added a database of modeling and simulation (M&S) tools. It uses an object-oriented approach to characterize the capabilities of M&S in a consistent and objective way. The taxonomy used is a notable departure from the text-based, descriptive approach found in most M&S catalogs. The M&S database presently contains twenty-three records, with monthly updates to follow in the future.

The DSC proposes to man a booth during the poster sessions, as part of which it will conduct demonstrations of the infrastructure using a laptop computer linked to a video monitor. These demonstrations are intended to: 1) familiarize more members of the C4ISR, M&S, and studies communities with this set of tools that has already received good marks from users; 2) obtain real-time feedback and suggestions from demo participants, to include identifying more studies and M&S that should be included; and 3) assist interested visitors in obtaining access to the analytic infrastructure.

Digitization for the Army After Next

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The tempo of modern combined arms warfare demands full exploitation of rapid processing and transfer of crucial battlefield information. Land force dominance at tactical and operational levels in the information age requires improved battle command, improved synchronization of direct and indirect fires, faster and more comprehensive access to intelligence data, enhanced situational awareness, and effective force protection. The need to rapidly shift battle focus, reconfigure forces, and move quickly and efficiently from one mission to another requires the ability to immediately transform data into useful information faster than the enemy. In the future, data will be gathered, processed, and delivered under the rubric of "digitization". The Department of Mathematical Sciences, USMA, is a resource to support the Army's effort to digitize the battlefield. The purpose of this presentation is to inform the Military Operations Research community about the Department's plans to contribute to the Army's digitization effort.

Evaluation of System Performance Using Supplementary Data

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During the various phases of system development it is important to maintain an estimate of whether the system will meet its performance requirements when it becomes "operational". Estimates of operational performance during development phases indicate whether the development is "on track" and are important criteria to be considered for advancing the program. In the development phase we obviously do not have a "population" of operational (i.e. production) items from which to sample. We must rely on development items for indications of how the operational item will perform. Furthermore, as systems become more complex, and expensive, the amount of total system testing decreases. Consequently, means other than just full system tests are needed to provide evidence on the performance of the system. Potential sources of information, other than full system tests, include subsystems and component tests and are denoted as "supplementary data". In order to use supplementary data to address the question of performance of the operational system, it is often necessary to invoke engineering judgment. We are developing a process that will quantify the effects of judgmental factors on the degree of belief in an estimate of whether a system will meet its requirements. An explicit evaluation of the degree of belief in meeting requirements, which includes effects of judgmental factors, has many advantages. This paper presents a description of the process, which has been named the "Expanded Confidence Assessment Process" (ExCAP), and its application to missile defense system evaluation.

Intelligent Animated Planning World (IAPW)

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We plan to demonstrate a animated three dimensional planning world that consists of military and terrain objects with behaviors that can be directed either by human intervention, scenario algorithms or autonomous intelligent algorithms. IAPW will be fully animated, three-dimensional and equipped with object and behavior files that will allow the creation of ops plans and intelligence preparation of the battlefield components in order to conduct course of action analysis (COAs). The objects will consists of military symbols, terrain features and both ground and aerial representations necessary to describe twenty-first century battle spaces. The behaviors will be both be locally assigned to particular battle objects and globally controlled by the operator to view all dimensions of the battle space. The operator will be able to zoom, travel within the world, rotate the world, query objects (as to troop strength for example) and slice the world into different sections to compare various views of the battle space. Individual battle objects can transverse terrain, fly pre-determined flight paths, respond to operator queries and respond appropriately to terrain features and man-made barriers. Later this summer we intend to use this world as a laboratory to investigate visualizations for intelligent COA systems. The first tool to be instantiated within IAPW will be FOX-GA which is a genetic algorithm that generates and evaluates COAs using a fitness function driven by terrain and force ratio criteria. The purpose for constructing IAWP is to conduct human in the loop experimentation. Our initial investigations will be to evaluate the utility of intelligent COA algorithms and the efficacy of various visualization variables using realistic scenarios. The demonstration at MORSS will focus on the IAWP environment and will not demonstrate the FOX-GA implementation or experimentation except as a conceptual possibilities.

Multiple Engagement Model Evaluation Study

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Simulation Based Acquisition

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The OSD exhibit presents OSD's and Industry's vision and goals for Simulation Based Acquisition (SBA). SBA is a revolutionary concept calling for a revised acquisition culture, process and technical environment leading to reduced cycle time and total cost of ownership.

Simulation Interoperability Standards Organization

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The Simulation Interoperability Standards Organization (SISO) is dedicated to the promotion of simulation interoperability and reuse for the benefit of the model and simulation developers, procurers, and users throughout the world. The SISO mission is to provide an open forum that promotes the interoperability and reuse of models and simulations through the exchange of ideas, examination of technologies, and the development of standards. This poster presentation will provide information about SISO and its efforts to provide the modeling and simulation community with a venue for the development of relevant standards and a forum to share experiences, resolve problems, and discuss strategies for the application and reuse of distributed simulations.

THAAD Operator Systems Interface Testing

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Modernizing controls and displays for military applications is a challenge since soldiers are understandably reluctant to use a new interface design on systems where life critical decisions are made. However, interaction efficiency is paramount to avoid fatigue and minimize error rates which could cost lives. Experimental command and control formats currently being developed by the Army+s THAAD (Theater High Altitude Area Defense) program are being tested with soldiers at Fort Bliss, Texas. Testing involves gathering operator performance based data, response times and error rates, and human throughput. Through the use of empirical based experiments, recommendations for the Graphic User Interface designs may be made based on operator performance rather than personal preference and existing industry standards. Incorporation of this research into the next generation of DoD Command and Control (C2) displays will enhance the ability of the soldier/operator to save the lives of civilians and other soldiers during military operations. Display formats have been tested which monitor the status of the THAAD system, command and control equipment, navigation of alert messages, and trouble shooting of the equipment. The display would feature graphic pictures of the prototyping process and graphs of experimental test results from soldier usability testing. Computer demonstrations of the candidate formats tested with soldiers will be shown.

Tools for the Knowledge Analyst: An Information Superiority Visionary Demonstration

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Approved abstract unavailable at printing.

USAF Prime Warrior Wargaming Course

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The Prime Warrior Formal Course is a Chief of Staff of the Air Force initiative to prepare Air Force participants for joint wargames, analyses, and exercises. The course was developed under the auspices of the Air Force XOC, Air Combat Command (ACC) and the Air Force Air Education and Training C9ommand (AETC). The course was designed and constructed by the USAF Wargaming Institute, Maxwell AFB, AL with support from Veridian/Veda Operations at Air University's College of Aerospace Doctrine, Research and Education (CADRE). The course was documented by, a Training Systems Requirements Analysis (TSRA) and validated by several pre-course offerings. This poster provides a complete description of the course' program of instruction, concentrates on the contents of four educational blocks; two supporting blocks on fundamentals of Operations Research and concepts of Modeling and Simulation, a block devoted to Doctrine and Operations, and the primary block on Wargaming and wargaming models. Viewers will find the poster content to be both enlightening and entertaining since the subject of wargaming carries both a military warfare and purely intellectual stimulating perspective. In addition, the poster will present several multimedia educational products which support this instruction.

OTHER SPECIAL EVENTS

Tuesday, 0715 - 0815 .... **Spanagel 101-A**
Working & Composite Group Warm-up
Coordinator: Dr. **Roy Rice**, Teledyne Brown Engineering

Wednesday, 0700 - 0800 .... **Club Del Monte**
Town Hall Breakfast Meeting (WG & CG Chairs)

Wednesday, 0700 - 0800 .... **Club Del Monte**
***PHALANX* Editor's Breakfast Meeting**
Coordinator: Dr. **Julian Palmore** , US Army CERL

Wednesday, 0700 - 0800 .... **Club Del Monte**
***Military Operations Research Journal* Editor's Breakfast Meeting**
Coordinator: Dr. **Gregory Parnell** , FS, Virginia Commonwealth University

Thursday, 1530 - 1700 .... **G-102**
Joint Senior Advisory Group (SAG) Meeting
Coordinator: Dr. **Jacqueline Henningsen** , FS, OSD (PA&E)

Thursday, 1500 - 1530 .... **Spanagel 101-A**
Working Group Wrap-Up

TBD .... **Root 208**
OSD Demonstration: Simulation Based Acquisition
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The OSD exhibit presents OSD's and Industry's vision and goals for Simulation Based Acquisition (SBA). SBA is a revolutionary concept calling for a revised acquisition culture, process and technical environment leading to reduced cycle time and total cost of ownership.

Wednesday, 1200-1515 and Thursday, 1030-1315 .... **Root 200C**
Demonstration - Platform Independent, Distributed, Dynamic, Map-based Military Planning Systems

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Joint Vision 2010, New World Vistas, Army Force XXI, Army After Next and other visions of the future uses of information technology expect that the military will face a broad range of missions that will involve unanticipated situations, changing coalitions, fast response, and dynamic changes. These operations will involve planning with other services, allies, non-military government agencies, and non-government agencies that will have a variety of hardware and software that operates across a heterogeneous computer network. For many missions, it will not be possible to pre-script the situations and thus planning systems must be flexible and be able to respond quickly to changing requirements.

The authors have designed and developed an architecture for advanced military planning systems that specifies software components that can be developed independently and then "loosely coupled" to dynamically construct planning systems that are platform independent, distributed and can be tailored to specific requirements.

The demonstration shows a map-based planning system applied to a Special Operations Forces scenario. The system displays maps and satellite images with multiple overlays that can contain friendly positions, enemy positions and networks (for example, roads, communications). The overlays allow drill-down for additional information and annotation by the user. The system includes operations research algorithms that execute on the nodes and arcs that are contained in the overlays. The system is written in 100% Java and thus can execute without modification or recompilation on a network of PC's, workstations, Macintosh's and other computer platforms. Maps, images, overlays and algorithms can be downloaded over a computer network and dynamically incorporated into the system.

TOURS

Sign-up for the GCCS Lab and War Lab Tours in the MORS Office.

Meet at the appropriate room at your tour time.

GCCS Lab/Systems Technology Laboratory (STL) .... Root Hall 202

One tour per day from 1215 – 1245 (20 people per tour).

The Systems Technology Lab (STL) is an advanced C4ISR laboratory that provides NPS students with a facility to learn and conduct research along with faculty researches in emerging joint C4ISR systems and technologies.

Signature features of the STL are our GCCS suite with live CINC data feeds and our wideband wide area internetworking capability via SIPRnet, LESN, DREN, and NIPRNET that allows access to and sharing of communications and research with other national labs and research activities. The STL also includes the West Coast's only GBS receive testbed.

Officer student-in-the-loop research experiments are routinely conducted in the STL using a variety of war games such as JTS, MTWS, JANUS, SIAM and others Sponsors of long term research projects in the STL include DARPA, ONR, DISA and NRL.

For the MORS tours we plan to focus on GCCS including demonstrating our real time COP (Common Operational Picture) i.e.; JMCIS, A look at one or two of GCCS CINC planning tools for logistics, examples from surfing the SECRET Internet (SIPRnet), a demo on our GBS downlink site. Those wishing to stay beyond the allotted time will be provided a look at some of our simulations (MTWS, JTS, JANUS, DDD) and how we use them in the STL (experiments with humans (student officers) in the loop). We can fine-tune the contents fairly easily.

War Lab – Secure Computing and Simulation Laboratory (SCSL) .... Ingersoll 157

Three tours per day from 1215 – 1230; 1230 – 1245 and 1245 – 1300 (8 people per tour).

The Secure Computing and Simulation Laboratory (SCSL) is utilized for modeling, simulation and gaming classes at NPS and for research focusing on understanding strategic issues, tactical analysis, systems evaluation, decision aiding/support, and Battle Force architecture and engineering. The tour of the facility will show you two of the models used in the SCSL: RESA (Research Evaluation and Systems Analysis) and JTLS (Joint Theater Level Simulation). A comparison of the two models will be discussed and there will be an opportunity for hands on interaction with the models.

TRADOC Analysis Center (TRAC) – Monterey – Open House

Need a break from the 66th MORSS? Come visit TRAC-Monterey's open house! All MORSS attendees are invited to see cutting edge computer simulation demonstrations, learn about TRAC projects, and learn about the history of TRAC-Monterey. The open house includes daily demonstrations of constructive combat simulations in stand alone and distributed modes. Hands-on opportunities to build and fight battlefield scenarios using the Janus high-resolution simulation. Fly the NPSNET virtual helicopter against hostile Janus entities. Don't miss the exciting opportunity to experience what the US Army TRADOC Analysis Center is all about! It will be held daily 23-25 June from 1200-1300 (refreshments will be provided). For details contact SFC **Chris Augustine** at 408-656-3086/4059 or by e-mail at augustic@mtry.trac.nps.navy.mil.

GENERAL INFORMATION
66TH MORSS FINAL PROGRAM

MORS Office

MORS will have an office at NPS during the 66th MORSS. It will be located in Room 122, Glasgow Hall. The office will be open on Thursday, 18 June, Friday, 19 June, and Monday 22 June, 0900-1700; on 23, 24, 25 June 0700-1730. The phone numbers for the MORS office at NPS are: 408-656-1058; FAX : 408-656-1053. DSN prefix is 878. They will be **activated on 18 June.**

Attendee Support: Computer and Phone Rooms

There will be computer support rooms in Glasgow 128 and Glasgow 203. Computers are loaded with the Microsoft Office Suite.

Phones will be available for attendee use in Glasgow Hall, Room 103; in the lobby of Ingersoll Hall; in the lobby of King Hall and in Spanagel 101A. They will have DSN and credit card access. In addition, pay phones are located throughout the buildings at NPS.

Government Quarters

A limited number of quarters are available at the Naval Postgraduate School. Call the BOQ to make a reservation, (408) 656-2060, DSN 878-2060.

Statements of Non-availability

Statements of non-availability WILL be provided in the event BOQ space is not available.

Lost and Found

The Lost and Found will be in the MORS office, Room 122, Glasgow Hall, during the Symposium. Lost and Found items not claimed at the end of the Symposium will be left with the host facility.

Mixer

There will be an informal mixer at the Club Del Monte on Tuesday evening, 23 June, from 1715-1900. There will be a cash bar. Transportation will be provided back to the hotels before and after the mixer.

Strolling Dinner at the Monterey Aquarium

On Wednesday evening, 24 June, there will be a Strolling Dinner at the Monterey Bay Aquarium from 1930-2330. Tickets for the Dinner are only $60 per person. That includes the entry fee into the aquarium. There will be a cash bar. Bus transportation will be provided from the hotels to the Aquarium and back.

Lunches and Snacks

The following facilities are available for lunch:

- Club Del Monte.
- Lunch is available from several take-out vendors in the courtyard between Ingersoll and Root Halls.
- Box lunches will be delivered to Glasgow Hall at 1130 for those who have ordered them.

Coffee

Coffee and snacks will be provided without additional charge. Coffee will be served on Tuesday, Wednesday and Thursday at the following times:

0700-0830	**1000 – 1030**	**1500-1530**

Snacks will be at King Hall and Glasgow Hall during registration on Tuesday morning. At other times, they will be at Glasgow Hall and in the lobby of Ingersoll Hall.

Designated Smoking Areas

Smoking is NOT permitted in any building at NPS. The designated smoking areas are located outside each building.

Bus Schedule to Conference from Hotels Tuesday – Thursday (23-25 June 1998)				
Route	**Depart**	**Depart**	**Depart**	**Arrive NPS**
Route #1 (1 bus)	Hyatt	Hilton		
	0635	0650		0700
	0715	0730		0740
Route #2 (1 bus)	Monterey Beach Hotel	*Hampton Inn Embassy Suites		
	0635	0650		0700
	0720	0735		0745
Route #3 (1 bus)	Best Western DeAnza	Travelodge Fairgrounds		
	0635	0650		0700
	0720	0735		0745
Route #4 (1 bus)	San Carlos	Best Western Monterey Inn	**Casa Munras/ Travelodge Downtown	
	0620	0630	0645	0655
	0715	0725	0740	0750
Route #5 (1 bus)	Carmel Mission Inn			
	0625			0650
	0725			0750

*** Pick-up and Drop-off for Hampton Inn & Embassy Suite Passengers at Hampton Inn.**
**** Pick-up and Drop-off for Casa Munras & Travelodge Downtown Passengers at Casa Munras**

Bus Schedule from Conference Tuesday – Thursday (23-25 June 1998)			
Route	**Depart NPS**	**Arrive Monterey Airport**	**Arrive All Hotels**
	*1215	1230	
! All Routes (5 buses)	*1515 1715		1530-1545 1730-1745

*** Thursday Only**
! Route#1 (Hyatt → Hilton) will proceed to the Airport after the 1515 & 1715 drop off on Thursday.

Tuesday Spouse Tour 6/23		Tuesday Mixer 6/23			Wednesday Spouse Tour (6/24)	
Depart Hyatt	**Return NPS O Club**	**Route**	**Depart NPS O Club**	**Arrive all Hotels**	**Depart Hyatt**	**Return Hyatt**
0900	**1630**	**All Routes (5 Buses)**	**1900**	**1915-1930**	**0900**	**1630**

Schedule to Wednesday Evening Social (6/24)				
Route	**Depart All Hotels**	**Arrive Aquarium**	**Depart Aquarium**	**Arrive All Hotels**
All Routes (5 Buses)	**1830**	**1900**	**2200 2300**	**2215-2230 2315-2330**

Security Matters

All attendees and speakers are US Nationals. All have SECRET clearances and need-to-know certified by competent authority.

Attendees are reminded of the necessity for continuing attention to security precautions. While every effort will be made to provide a secure facility for the meeting and to insure that attendees are properly identified, cleared, and in possession of the required need-to-know, all are reminded that the responsibility for the unauthorized disclosure, particularly with regard to conversations, rests with the individual attendee. Attendees are requested to keep in mind the following important points:

1. Be careful WHERE you make classified disclosures. Do not extend classified discussion to hotels, restaurants, officers' clubs, or other places in which you are unable to positively identify all within hearing distance and be reassured of the nonexistence of eavesdropping devices.
2. Be careful TO WHOM you make classified disclosures. You should assure yourself that the people to whom you are talking are indeed registrants at the 66th MORSS. You are advised that a uniformed or civilian person located away from the restricted area of the meeting and not personally recognized as a registrant does not have authorized access to classified information, regardless of his possession of a MORS name badge.
3. The attention of non-government attendees is invited to the NISPOM, Chapter 5, Section 5, with regard to disclosure authorizations.
4. Attendees are advised that possession of photographic, audio recording or electronic transmitting devices is not authorized in the meeting spaces of the 66th MORSS.

Admission Policy

Admission to the secure area of the meeting is limited to holders of current printed invitations properly authenticated and issued by the MORS office to the named individual for his attendance at the 66th MORSS.

Persons who enter or attempt to enter the secure area of the meeting without proper invitation and persons who aid, encourage, or willfully permit improperly authorized persons to enter the secure area of the meeting are liable for citation for security violation.

Invitations

The only admissible invitation is the official 66th MORSS Invitation issued by the MORS Office. Other invitations, including official invitations for earlier MORSS, are inadmissible. There is no provision for one-session-only invitations and MORS has no obligation to issue invitations after the announced deadline or to work out invitations for persons who arrive uninvited at the meeting. ***Invitations must be brought to the meeting. They are required for registration.***

Restricted Meeting Areas

For the 66th MORSS, the designated restricted meeting areas are inside the assigned working group, composite group and general session rooms. All classified presentations and discussions in connection with the MORSS program are to be conducted inside these rooms. Classification signs must be posted in each room to designate the classification of any presentation or session Only the following persons are permitted access to MORS meeting areas:

- Officially invited 66th MORSS attendees with appropriate MORS-issued name badges and approved ID cards;
- MORS staff and service personnel with appropriate MORS-issued name badges and approved ID cards;
- Members of the 66th MORSS guard force;
- Officials representing the host command on official business.

Entry to the Meeting Areas

Entry to the restricted meeting areas will be regulated by the guard force and working group chairs and cochairs.

At each entry to a meeting room, each attendee will be required to stop long enough to show his properly validated 66th MORSS name badge and his identification and to be recognized by the guards. The name badge and ID card should be displayed at all times within the restricted meeting area. The guards or working group chairs and cochairs will check the following before admitting an attendee to the classified area:

- The validity of the ID card

- The validity of the name badge
- The correspondence of face and ID picture
- The correspondence of name on badge and ID card.
-

So that the ID check can be accomplished quickly, name badges and ID cards must be displayed together in the MORS name badge holder.

Picture ID Cards

All attendees in the restricted meeting areas are required to display their ID cards in the MORS badge holders along with their name badges. Only three types of ID cards are permissible: the active duty military ID card, the ID card issued by MORS and NPS civilian ID cards The MORS-issued ID cards will be delivered to the attendees when they register. Please return the MORS ID Card to MORS at the end of the symposium.

MORS Name Badges

A MORS name badge is issued to each properly registered attendee, along with a plastic pouch for its display. Attendees should take care that the badge is not lost or loaned during the meeting as these are avenues for improper entry and security violations. Badges should not be changed, corrected, or altered in any way. If necessary, a member of the MORS staff will issue a new badge at the MORS Office.

Note Taking

Classified presentations shall be delivered orally and/or visually. Classified documents shall not be distributed and classified note-taking and electronic recordings shall not be permitted by attendees during classified presentations.

Classified Matter -- Transmittal

Those desiring to send classified material in advance of their arrival should address it (for attendee pickup) in the following manner:

Classified Material Control
Naval Postgraduate School
144 Bouldry Rd., Room 206
Monterey, CA 93943-5015

(408) 656-2450, DSN: 878-2450

The lower left corner of both the outer and inner envelopes should show the following information:

Hold for MORSS Attendee:
Your Name
Your Company or Organization

NPS will provide your package to the MORS Office at NPS where you may retrieve it when you arrive at the Symposium, after 1000 on Tuesday, 23 June 1998.

Please note: Capability to perform *major* reproduction of your materials once you arrive at NPS WILL NOT be provided.

When no longer needed for the Symposium, attendees may bring their classified material to the MORS office to be wrapped for hand carry or transmittal to their parent activity. ***The attendee is responsible for providing a letter of transmittal to be included in the package.*** The meeting security staff will be responsible for proper wrapping and marking of inner and outer envelopes in accordance with Navy security regulations. The address for classified mail shown on the attendee's personal security voucher will be used for mailing purposes. MORS will accept responsibility for mailing a properly wrapped and sealed package by registered mail and will provide the attendee with a receipt for the sealed package. Because of congestion, MORS staff will not be able to wrap packages during the breaks between sessions.

Classified Matter -- Overnight Storage

The MORS office will accept (until 15 minutes after the end of the last session) and safeguard (for the meeting duration) classified matter to the level of SECRET. Material will be accepted as a package rather than loose. Receipts must be presented on recovery of material by its holder. The MORS office staff is cleared to the SECRET level.

Classified Disclosure

Persons participating in the discussions at the 66th MORSS have been granted limited disclosure authorization via their personal security vouchers for the 66th MORSS. It is the individual responsibility of each participant to find out in advance, from his certifying official, the limits to his own classified disclosures and to stay within those limits at the symposium.

A written disclosure authorization is required for all papers and presentations (government and contractor). All disclosure authorizations must be forwarded to the MORS Security Manager on or before **15 May 1998**. Attach an unclassified abstract which has been stamped *Approved for Public Release; Distribution Unlimited* to the disclosure form. If the disclosure authorization is not received by MORS prior to the symposium, the presentation will be canceled. A disclosure form was provided in the Registration Packet. Request additional disclosure forms from the MORS office.

Applicable Distribution Statement

The *Applicable Distribution Statement* is frequently overlooked and the primary reason for returning a disclosure form to the author for completion. This section of the form MUST be completed and is found at the end of the MORS Disclosure Authorization Form.

MORS Purposes and Objectives

The purpose of the Military Operations Research Society is to enhance the quality and effectiveness of classified and unclassified military operations research. To accomplish this purpose, the Society provides media for professional exchange and peer criticism among students, theoreticians, practitioners, and users of military operations research. These media consist primarily of the traditional annual MORS symposia (classified), their published proceedings, special mini-symposia, workshops, colloquia and special purpose monographs. The forum provided by these media is directed to display the state of the art, to encourage consistent professional quality, to stimulate communication and interaction between practitioners and users, and to foster the interest and development of students of operations research. In performing its function, the Military Operations Research Society does not make or advocate official policy nor does it attempt to influence the formulation of policy. Matters discussed or statements made during the course of its symposia or printed in its publications represent the positions of the individual participants and authors and not of the Society.

The Military Operations Research Society is operated by a Board of Directors consisting of 30 members, 28 of whom are elected by vote of the Board to serve a term of four years. The persons nominated for this election are normally individuals who have attained recognition and prominence in the field of military operations research and who have demonstrated an active interest in its programs and activities. The remaining two members of the Board of Directors are the immediate Past President who serves by right and the Executive Vice President who serves as a consequence of his position. A limited number of Advisory Directors are appointed from time to time, for a 1-year term, to perform some particular function. In addition to the members, the Society maintains a general distribution list of its clientele to whom announcements, newsletters, and information are routinely sent.

The MORS Board of Directors wants to make the meetings and other operations of the Society as responsive as possible, both to the needs of the times and the desires of the members. Consequently, attendees are invited to communicate their relevant ideas and thoughts to any Officer or other Director or to the Society in writing. Where practicable, your communications will be duplicated and furnished to the MORS Board Members and Program Chairs for guidance in respect to future plans and operations.

The following are particularly encouraged:

- Offers of help in future symposium programs and working groups.
- Proposals for establishing new working groups.
- Suggestions for future banquet speakers, keynote speakers, meeting themes, meeting sites, arrangement improvements.
- Constructive criticism of current operations or programs.

The Society will consider all comments, suggestions, and proposals.

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Notes

Notes

66th MORSS Working Group / Classroom Match Up

Composite Group Number	Working Group Number	TIMES									
		Tuesday							Wednesday		
		0730-0830 Warm-up Session	0830-1000 Plenary Session	1030-1200 WG Session 1	1215-1315 Tutorials Session 1	1330-1500 WG Session 2	1530-1700 Special Session 1	1715-1900 Mixer	0830-1000 WG Session 3	1030-1200 WG Session 4	1215-1315 Tutorials Session 2
A	1			CG - A		I-280			I-280	I-122	
A	2					I-282			I-282	I-282	
A	3	C	P			I-285	S	M	I-285	I-122	
A	4	G	L	1-122		I-271	P	I	I-271	I-271	
B	5	/	E	G-129			E	X	G-102	G-102	
B	6A	W	N	G-303	T	CG - B	C	E	G-102	G-303	T
B	6B	G	A	G-306	U	G-109	I	R	G-102	G-306	U
B	6C		R	-----	T		A		-----	-----	T
B	7	W	Y	G-133	O		L		G-133	G-133	O
B	8	A		G-018	R	I-122			G-018	G-018	R
B	9	R	S	G-017	I	G-017	S		G-017	G-017	I
B	10	M	E	G-117	A	CG - B	E		G-117	G-117	A
B	11		S	R-240	L	G-109	S	C	G-102	G-102	L
C	12	U	S	G-110		G-110	S	L	CG - C	G-110	
C	13	P	I	G-113		Joint	I	U	G-109	CG - C	
C	14		O	G-114		G-102	O	B		G-109	
C	15	S	N	G-130		G-130	N		G-130	G-130	
C	16	E		G-118		G-118		D	I-122	G-118	
C	17	S		G-115	G-115	G-115	SS1	E	G-115	CGC/G-109	G-115
D	18	S	K	CG - D		I-265		L	I-265	I-265	
D	19	I	I		S	I-263	(2)		I-122	I-263	S
D	20	O	N	G-109	E	I-267		M	I-267	I-267	E
E	21	N	G	I-369	S	I-369		O	I-369	I-369	S
E	22			I-325	S	I-325		N	I-325	I-325	S
E	23	S	H	I-381	I	I-381		T	I-381	I-381	I
F	24	P	A	I-323	O	I-323		E	I-323	I-323	O
F	25	-	L	I-322	N	I-322			I-322	I-322	N
F	26	1	L	I-260		I-260			I-260	I-260	
F	27	0		R-242	T1	R-242			R-242	R-242	T2
F	28	1		I-119		I-122			I-119	I-119	
G	29	A		ME-146	(1)	ME-146			ME-146	ME-146	(3)
G	30			ME-145		ME-145			ME-145	ME-145	
G	31			ME-150		ME-150			ME-150	ME-150	
G	32			ME-147		ME-147			ME-147	ME-147	

G - Glasgow Hall
I - Ingersoll Hall
R - Root Hall
SP - Spanagel Hall

ME - Mech Eng Bldg
----- WG does not meet
1st WG in CG shaded gray

(1) T1 Schedule on Page 6
(2) SS1 Schedule on Page 2
(3) T2 Schedule on Page 7

66th MORSS Working Group / Classroom Match Up

Composite Group Number	Working Group Number	TIMES: Wednesday 1330-1500 WG Session 5	Wednesday 1530-1700 Special Session 2	Wednesday 1730-2100 Strolling Dinner	Thursday 0830-1000 WG Session 6	Thursday 1030-1200 WG Session 7	Thursday 1215-1315 Tutorials Session 3	Thursday 1330-1500 WG Session 8	Thursday 1500-1530 Wrap-up Session	Thursday 1530-1700 Special Session 3
A	1	I-280			I-280	I-280		I-280		
A	2	I-282			I-282	I-282		I-282		
A	3	I-285	S	A	I-285	I-285		-----	C	S
A	4	I-271	P	Q	I-271	I-271		I-271	G	P
B	5	-----	E	U	G-129	G-129		G-129	/	E
B	6A	G-303	C	A	G-303	G-303	T	G-303	W	C
B	6B	G-306	I	R	G-306	G-306	U	G-306	G	I
B	6C	-----	A	I	-----	G-386	T	G-386		A
B	7	G-133	L	U	G-133	G-133	O	G-133	W	L
B	8	G-018		M	G-018	G-018	R	G-018	R	
B	9	G-017	S		G-017	G-017	I	-----	A	S
B	10	G-117	E	S	G-117	G-117	A	G-117	P	E
B	11	G-102	S	T	G-102	R-240	L	R-240		S
C	12	G-110	S	R	G-102	G-110		G-110	U	S
C	13	Joint	I	O	Joint	G-113		G-113	P	I
C	14	G-109	O	L	G-109	G-114		G-114		O
C	15	G-130	N	L	G-130	G-130		G-130	S	N
C	16	G-102		I	G-118	G-118		G-118	E	
C	17	G-115	SS2	N	G-115	G-115	G-115	G-115	S	SS3
D	18	I-265		G	I-265	I-265		I-265	S	
D	19	I-263	(4)		I-263	I-263	S	I-263	I	(6)
D	20	I-267		D	I-267	I-267	E	I-267	O	
E	21	CG - E		I	I-369	I-369	S	-----	N	
E	22			N	I-325	I-325	S	I-325		
E	23	I-122		N	I-381	I-381	I	-----	S	
F	24	I-323		E	CG F/I-122	I-323	O	I-323	P	
F	25	I-322		R	I-322	I-322	N	I-322	-	
F	26	I-260			CG - F	I-260		I-260	1	
F	27	R-242			I-122	R-242	T3	-----	0	
F	28	I-119				I-119		I-119	1	
G	29	ME-146			ME-146	CG - G	(5)	ME-146	A	
G	30	ME-145			ME-145			ME-145		
G	31	ME-150			ME-150	Mech Eng		ME-150		
G	32	ME-147			ME-147	Aud		ME-147		

G - Glasgow Hall
I - Ingersoll Hall
R - Root Hall
SP - Spanagel Hall

ME - Mech Eng Bldg
----- WG does not meet
1st WG in CG shaded gray

(4) SS2 Schedule on Page 4
(5) T3 Schedule on Page 7
(6) SS3 Schedule on Page 5

Non-WG 66th MORSS Room Assignments

TYPE	TIME	TITLE	1998 66th MORSS Size	1998 66th MORSS Room
		Monday, June 22nd		
Tutorial	1300-1700	Operations Research in Spreadsheets	180	G-109
Tutorial	1300-1700	Evolutionary Programming	140	G-102
		Tuesday, June 23rd		
CG	1030-1200	Composite Group A	180	I-122
CG	1030-1200	Composite Group D	180	G-109
Tutorial	1200-1330	Littoral Undersea Warfare	140	G-102
Tutorial	1200-1330	How to Conduct a Successful WG	44	G-118
Tutorial	1200-1330	Marketing Operations Research #1	180	G-109
Tutorial	1200-1330	Bayesian Networks #1	180	I-122
CG	1330-1500	Composite Group B	180	G-109
Joint	1330-1500	Working Groups 13 & 14	140	G-102
Joint	1330-1500	Working Groups 8 & 28 (optional for WG 8)	180	I-122
SS1	1530-1700	Leadership in an Information Dominant Battle	>1000	King Hall
SS1	1530-1700	Mini-Symposium: Complexity & Warfare Analysis	180	G-109
SS1	1530-1700	Mini-Symposiums: QDR QNALYSIS & DoD Infrastructure	140	G-102
SS1	1530-1700	Prize Paper Session	180	I-122
		Wednesday, June 24th		
CG	0830-1000	Composite Group C	180	G-109
Joint	0830-1000	Working Groups 5, 6 & 11	140	G-102
Joint	0830-1000	Working Groups 16 & 19	180	I-122
CG	1030-1200	Composite Group C	180	G-109
Joint	1030-1200	Working Groups 1 & 3	180	I-122
Joint	1030-1200	Working Groups 5 & 11	140	G-102
Tutorial	1200-1330	Lessons from Mogadishu	145	Mech Eng Aud
Tutorial	1200-1330	How to Conduct a Successful WG	44	G-118
Tutorial	1200-1330	Marketing Operations Research #2	180	G-109
Tutorial	1200-1330	Bayesian Networks #2	180	I-122
CG	1330-1500	Composite Group E	180	I-122
Joint	1330-1500	Working Groups 13 & 14	180	G-109
Joint	1330-1500	Working Groups 11 & 16	140	G-102
SS2	1530-1700	Validation Methodologies	>1000	King Hall
SS2	1530-1700	Mini-Symposium: SIMTECH 2007	180	G-109
SS2	1530-1700	Jr/Sr: OSD	44	G-115
SS2	1530-1700	Jr/Sr: Army	40	G-118
SS2	1530-1700	Jr/Sr: Air Force	37	G-130
SS2	1530-1700	Jr/Sr: Navy	36	G-113
SS2	1530-1700	Jr/Sr: Marines	36	G-114

Non-WG 66th MORSS Room Assignments

TYPE	TIME	TITLE	1998 66th MORSS	
			Size	Room
		Thursday, June 25th		
SAG	0730-0815	Joint SAG - JS view of the QDR (RAND)	140	G-102
CG	0830-1000	Composite Group F	180	I-122
Joint	0830-1000	Working Groups 13 & 14	180	G-109
Joint	0830-1000	Working Groups 11 & 12	140	G-102
CG	1030-1200	Composite Group G	180	Mech Eng Aud
Tutorial	1200-1330	Marketing Operations Research #2	180	G-109
Tutorial	1200-1330	Bayesian Networks #2	180	I-122
SS3	1530-1700	VADM Panel Discussion	>1000	King Hall
SS3	1530-1700	Education Colloquim	140	G-102
		Throughout Symposium (June 22nd - 25th).		
Office	Throughout	MORS Office	-----	G-122
Phones	Throughout	Phone Room	-----	G-103
Computer	Throughout	Computer Support Rooms	-----	G-128/G-203
VIP	Throughout	VIP Phones (2nd Floor Glasgow)	-----	TBD
VIP	Throughout	VIP Phones (3rd Floor Glasgow)	-----	TBD
Meeting	Throughout	Executive Council	-----	G-388
Meeting	Throughout	67th MORSS Committee	-----	G-389
Demo	Throughout	Computer Demo: OSD	30	R-208
Demo	Throughout	Demo: NPS	30	R-200C

HOW TO FIND IT AT THE 66TH MORSS

MORS Office – Glasgow Hall, Room 122

Opening Session – King Hall Auditorium

Phones – Glasgow Hall, Room 103, Ingersoll Hall, Lobby, King Hall Lobby, Spanagel Hall, Room 101A

Computers – Glasgow Hall, Rooms 128 and 203

Computer Demo Room – OSD Demo – Root Hall, Room 208

Working Group Rooms – Glasgow Hall, Ingersoll Hall, Root Hall and Mechanical Engineering Building

Composite Group Rooms – Glasgow Hall, Ingersoll Hall, Mechanical Engineering Auditorium, King Hall

Tutorials and Special Sessions Rooms – Glasgow Hall, Ingersoll Hall, Mechanical Engineering Auditorium and King Hall

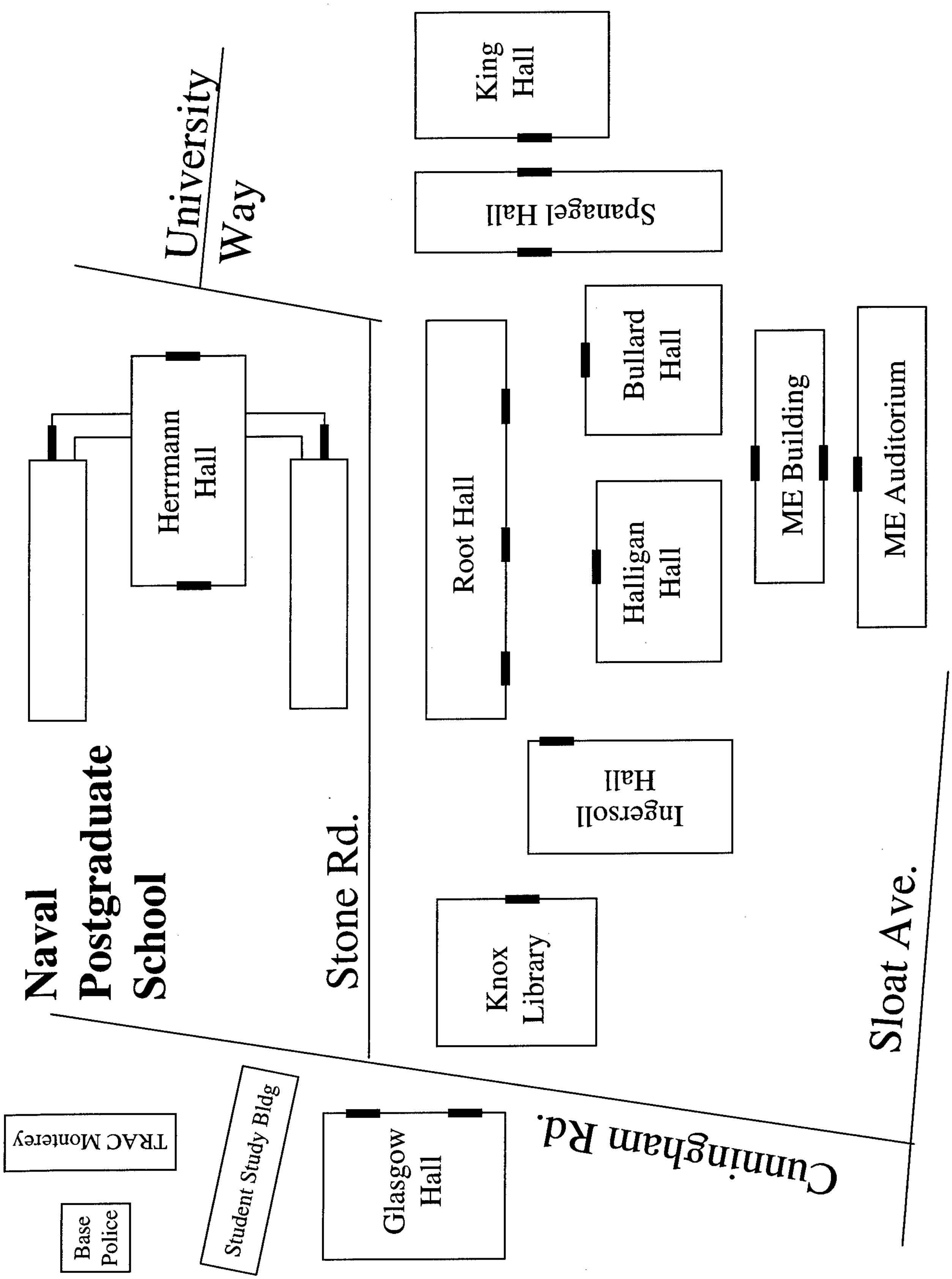
MORS Executive Council Room – Glasgow Hall, Room 388

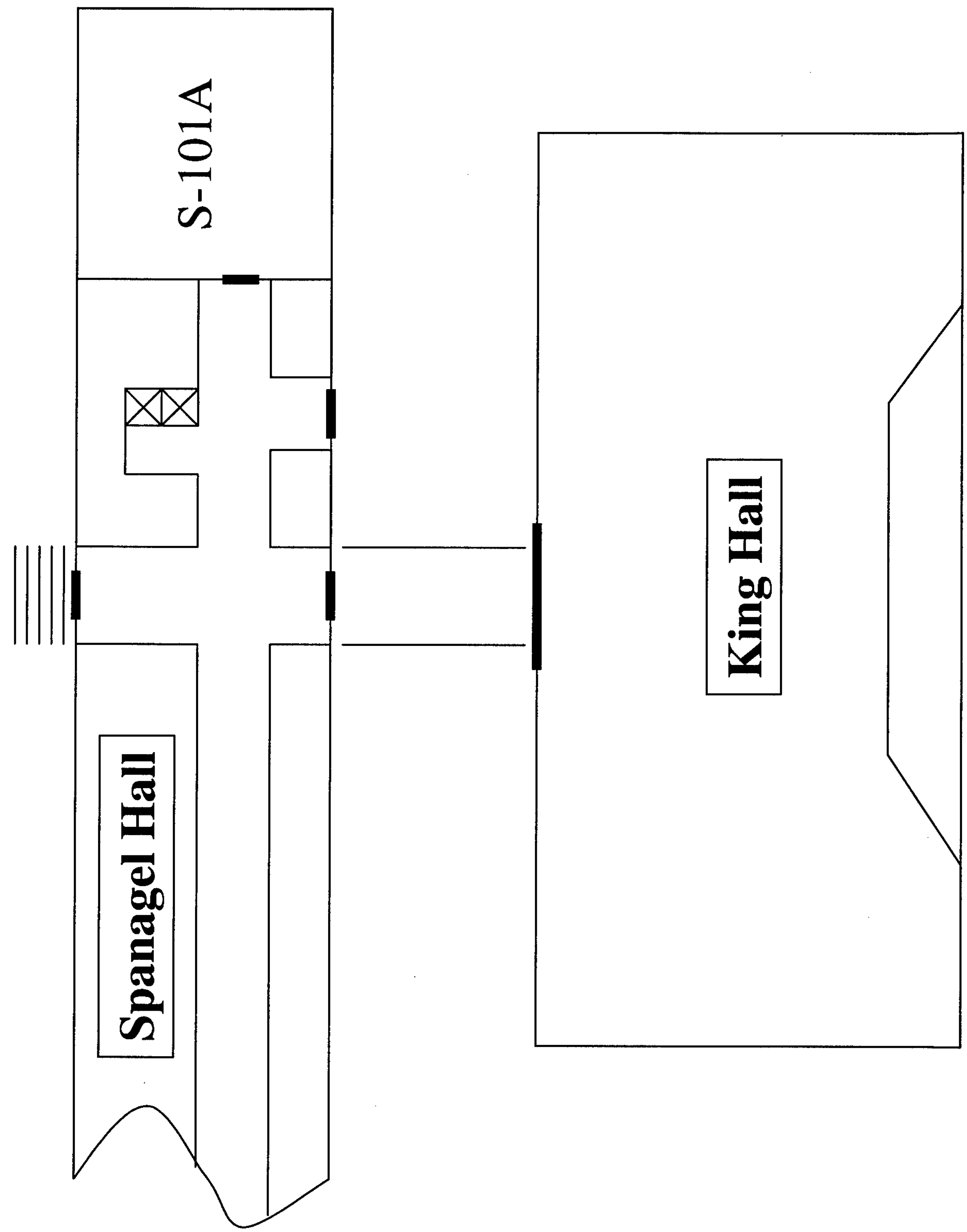
67th MORSS Committee Room – Glasgow Hall, Room 389

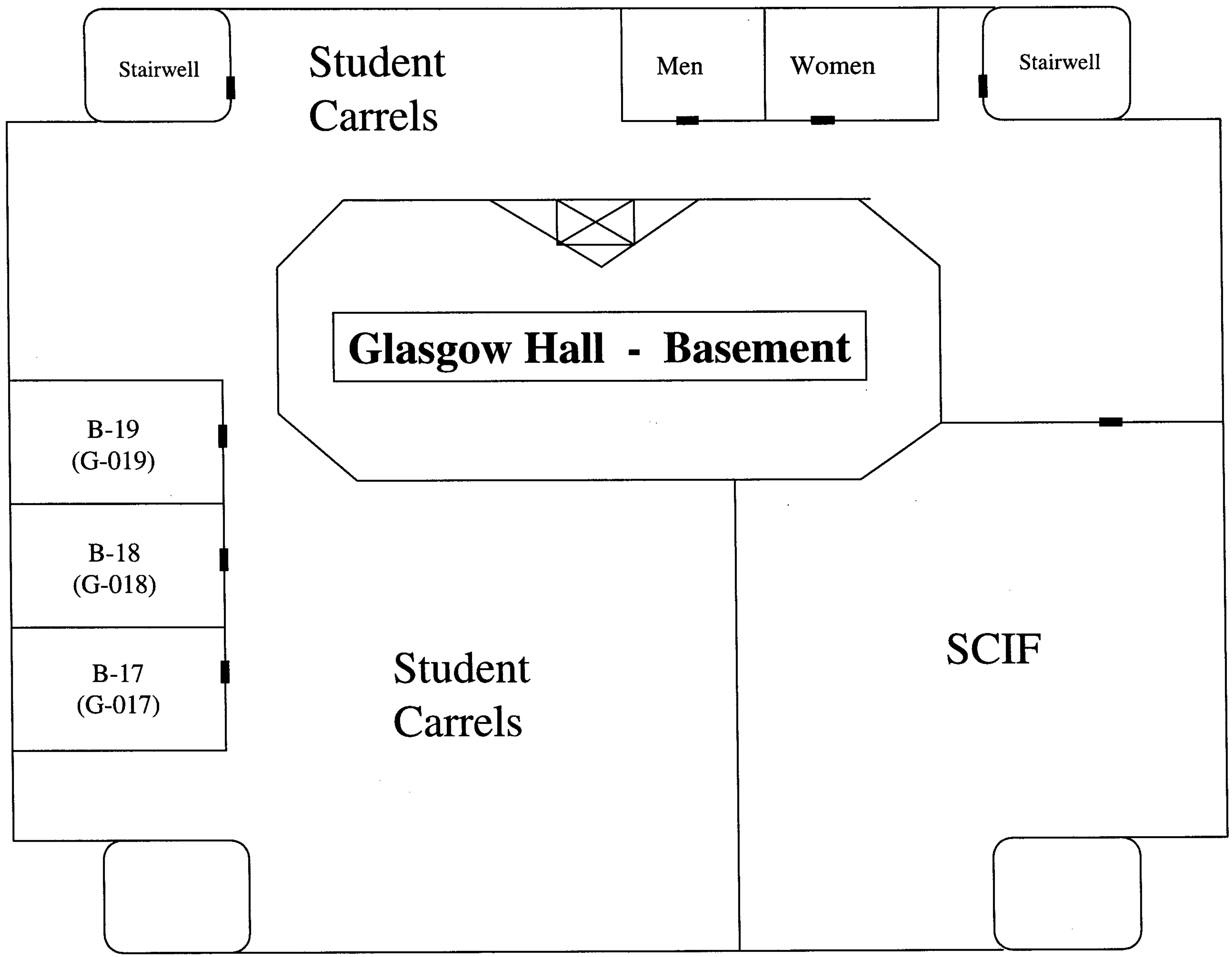
Mixer, Poster Sessions, Lunch – Herrmann Hall, Club Del Monte

Pick Up Box Lunches – Glasgow Hall (outside MORS Office)

Refreshments – Glasgow Hall and Lobby of Ingersoll Hall


Naval Postgraduate School
University Way
Stone Rd.
Sloat Ave.
Cunningham Rd.
King Hall
Spanagel Hall
Herrmann Hall
Root Hall
Bullard Hall
Halligan Hall
ME Building
ME Auditorium
Ingersoll Hall
Knox Library
Glasgow Hall
Student Study Bldg
TRAC Monterey
Base Police


S-101A
King Hall
Spanagel Hall


Glasgow Hall - Basement
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Student
Carrels
Men
Women
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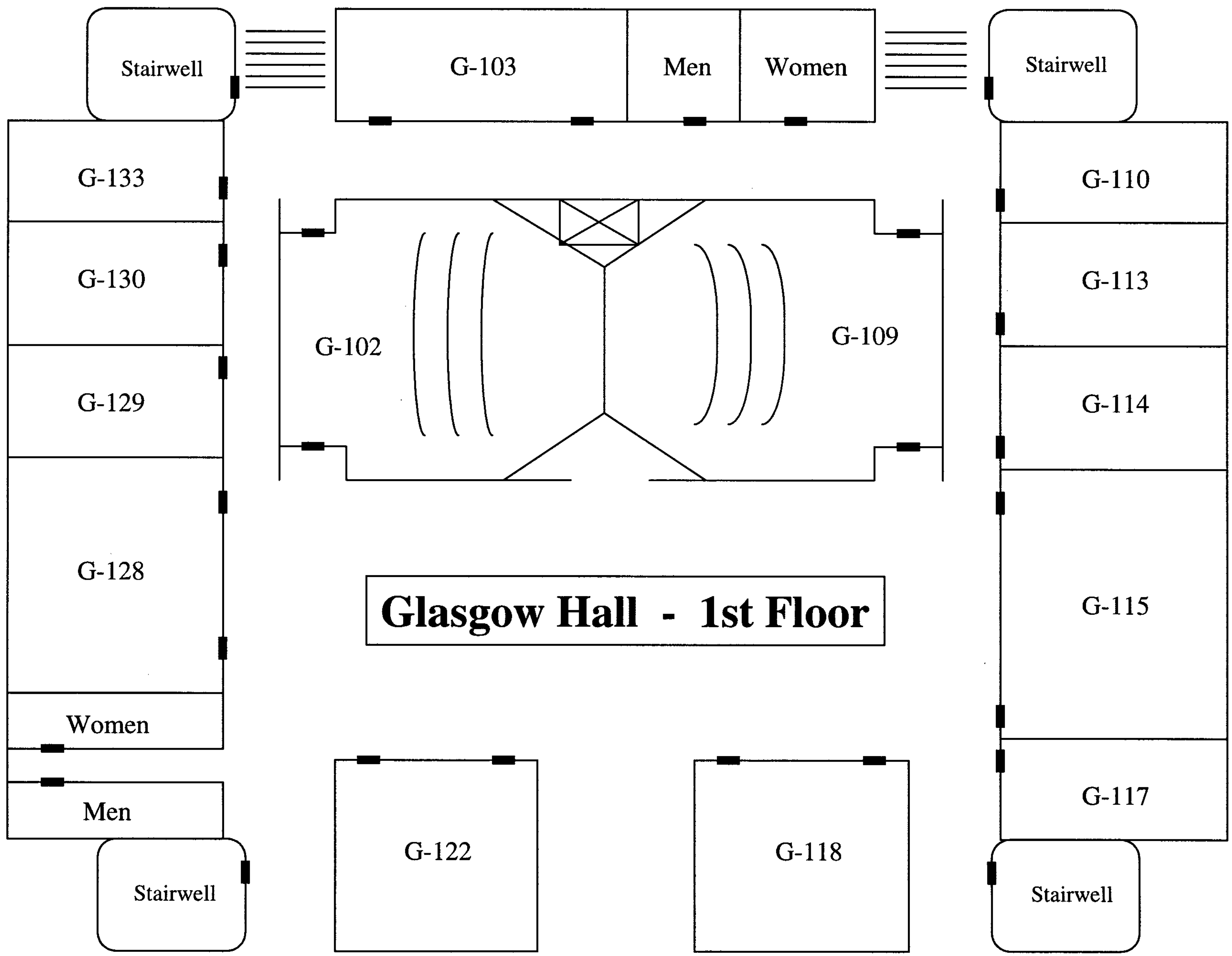
(G-019)
B-18
(G-018)
B-17
(G-017)
Student
Carrels
SCIF


Glasgow Hall - 1st Floor
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Women
Stairwell
G-133
G-130
G-129
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Women
Men
Stairwell
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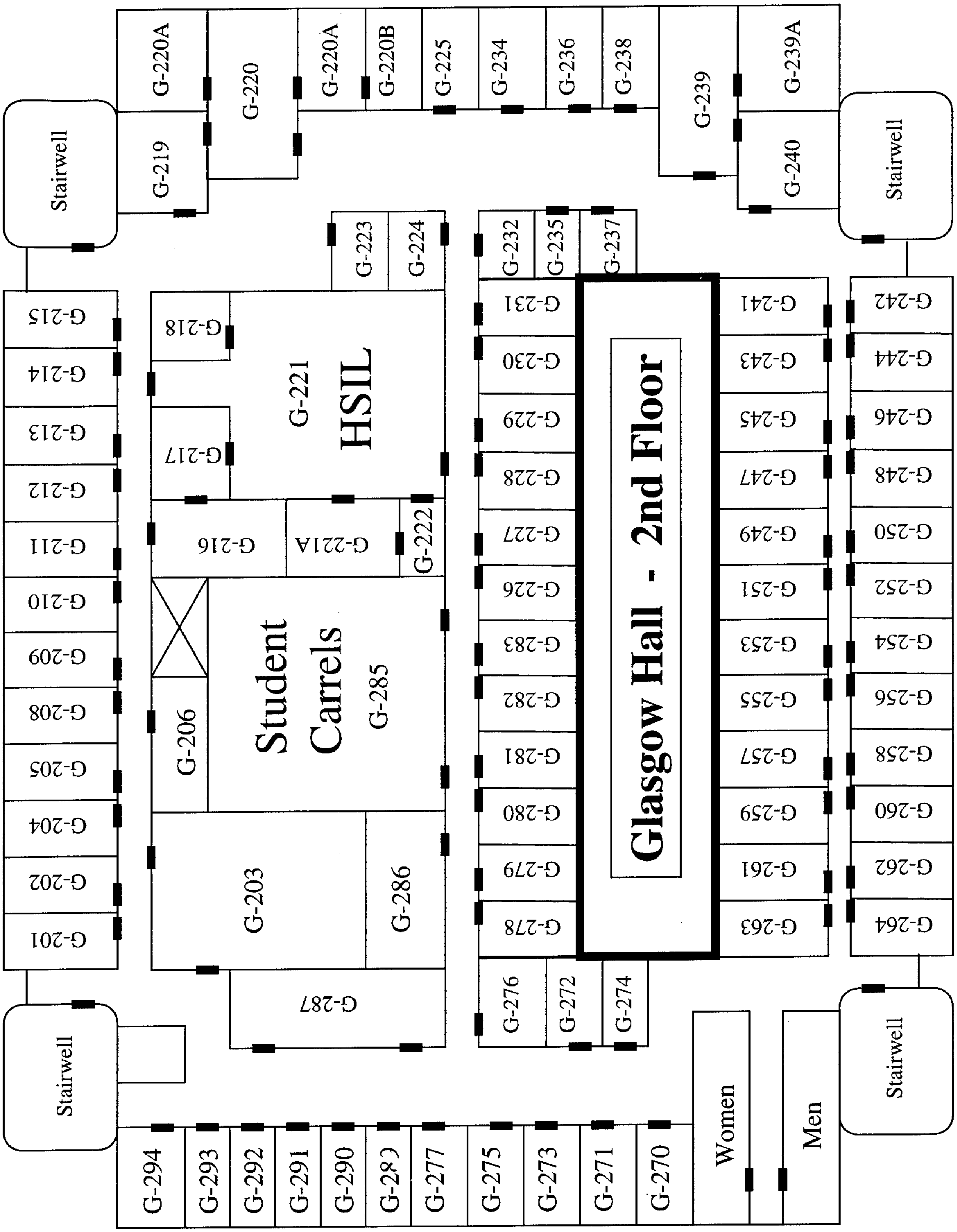
G-114
G-115
G-117
Stairwell
G-122
G-118


Glasgow Hall - 2nd Floor
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G-221A
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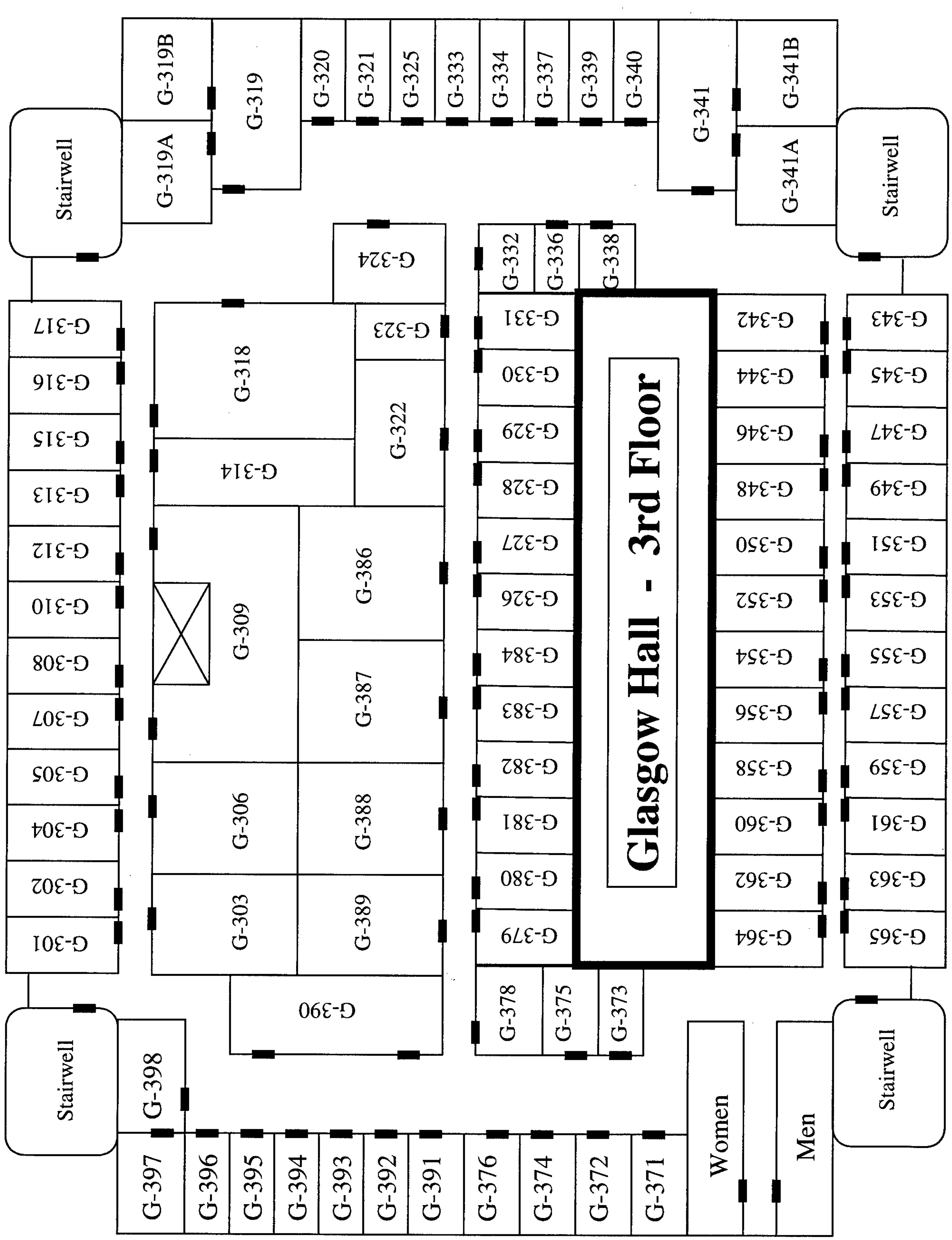
Glasgow Hall - 3rd Floor
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G-398
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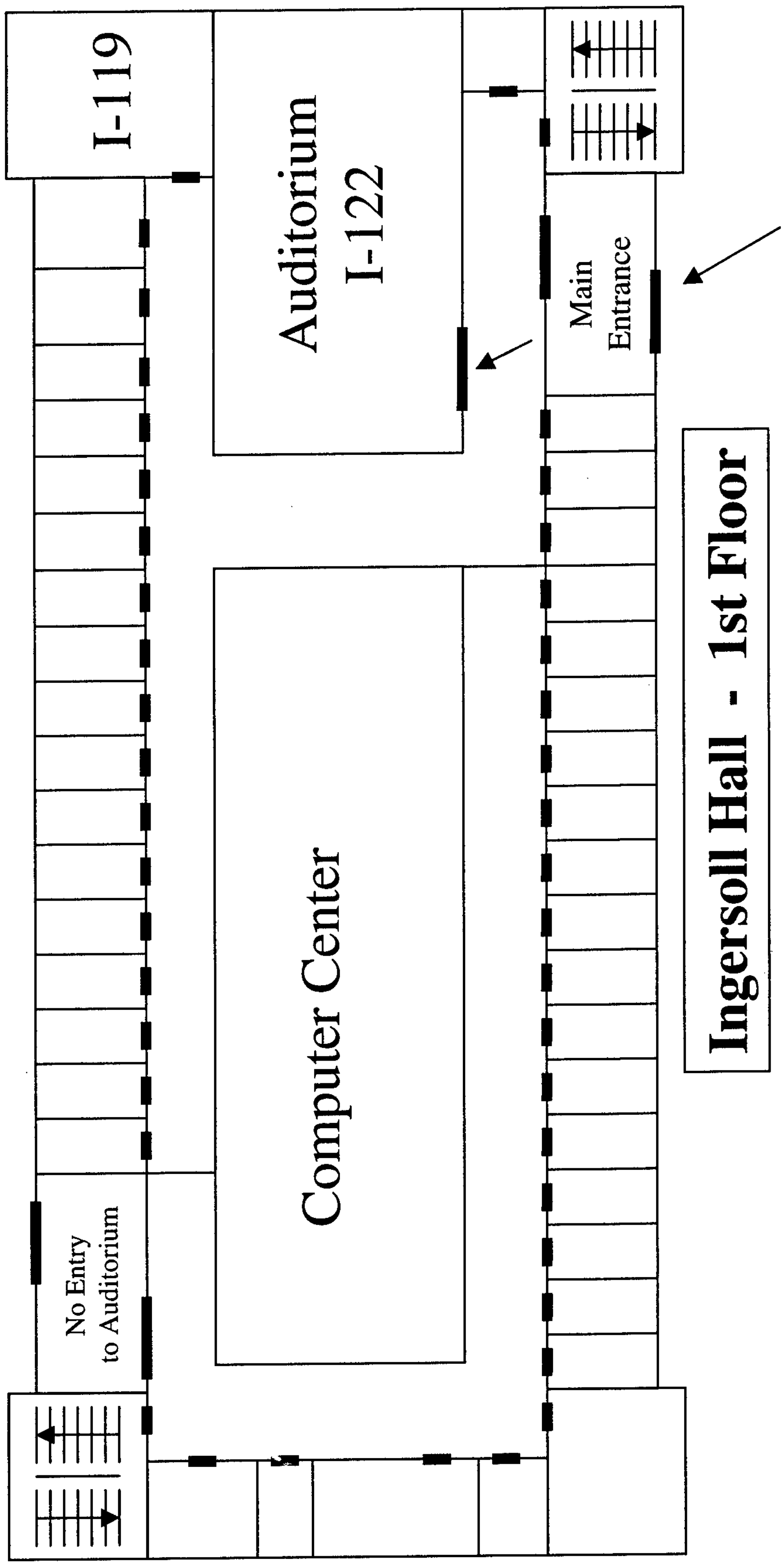
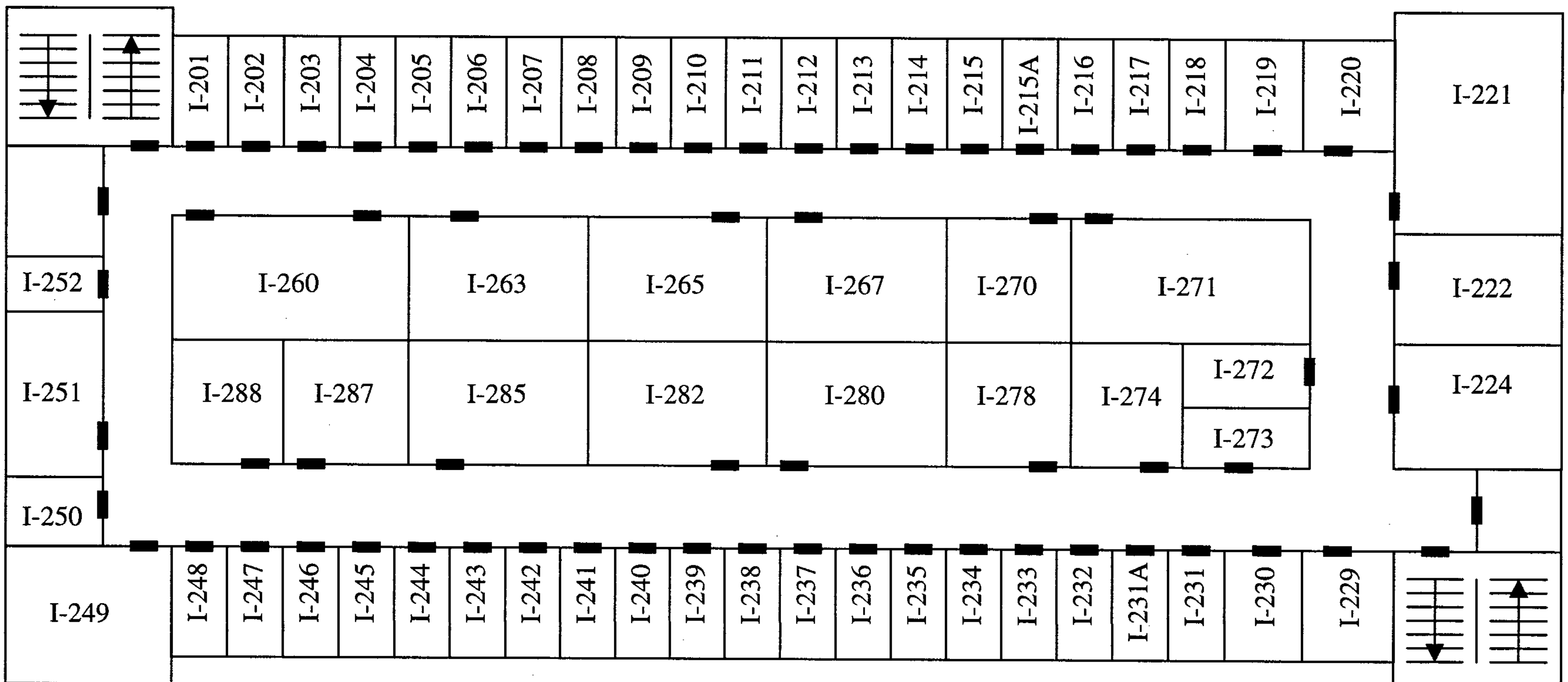
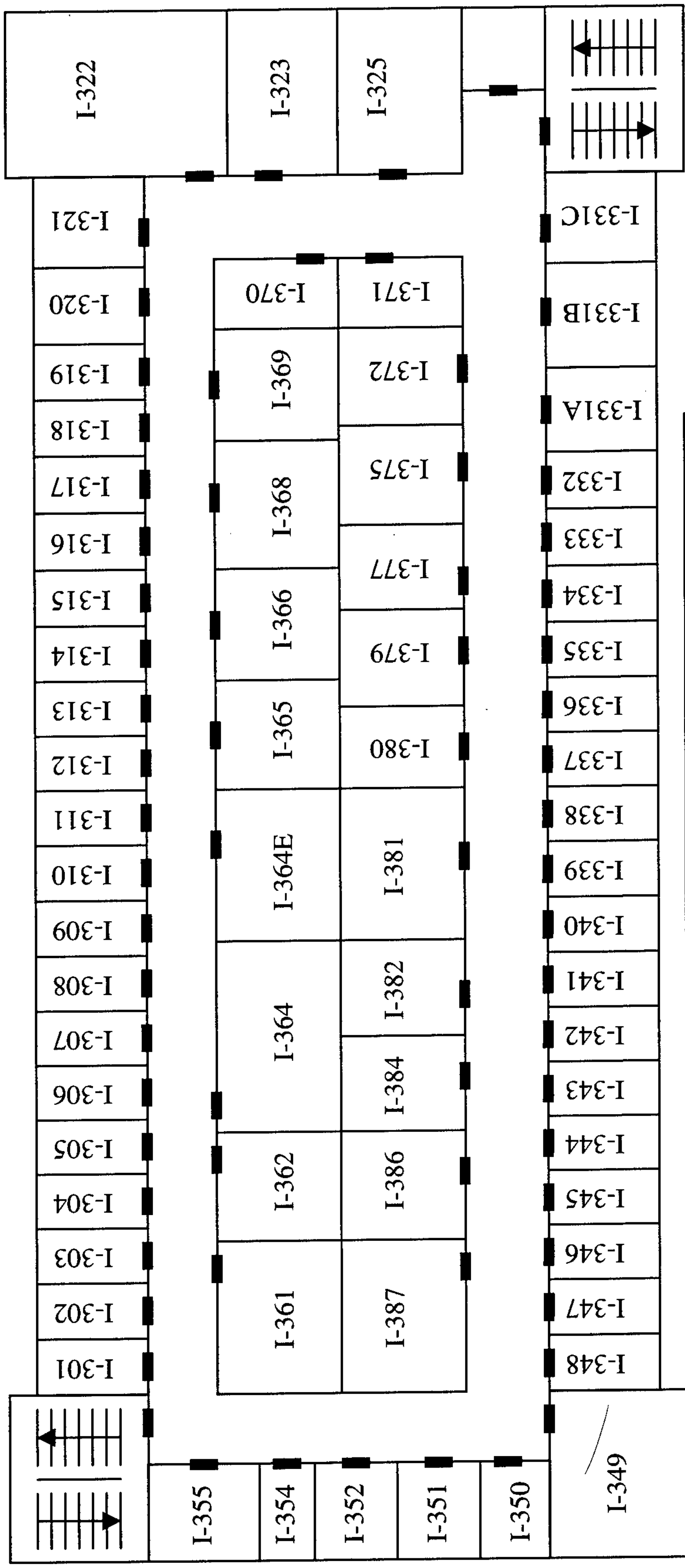
G-371
Women
Men



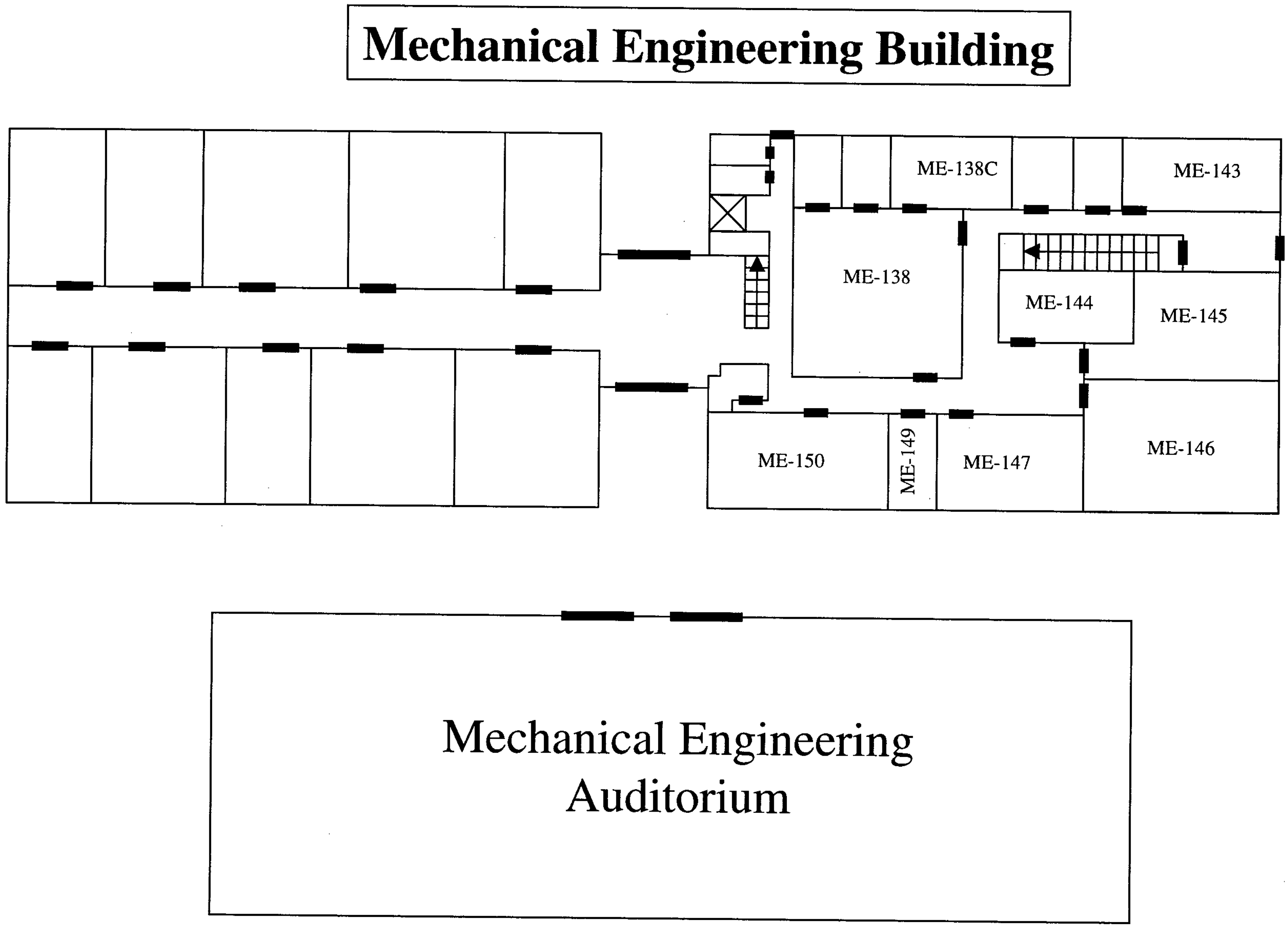
I-119
Auditorium
I-122
Main
Entrance
No Entry
to Auditorium
Computer Center
Ingersoll Hall - 1st Floor

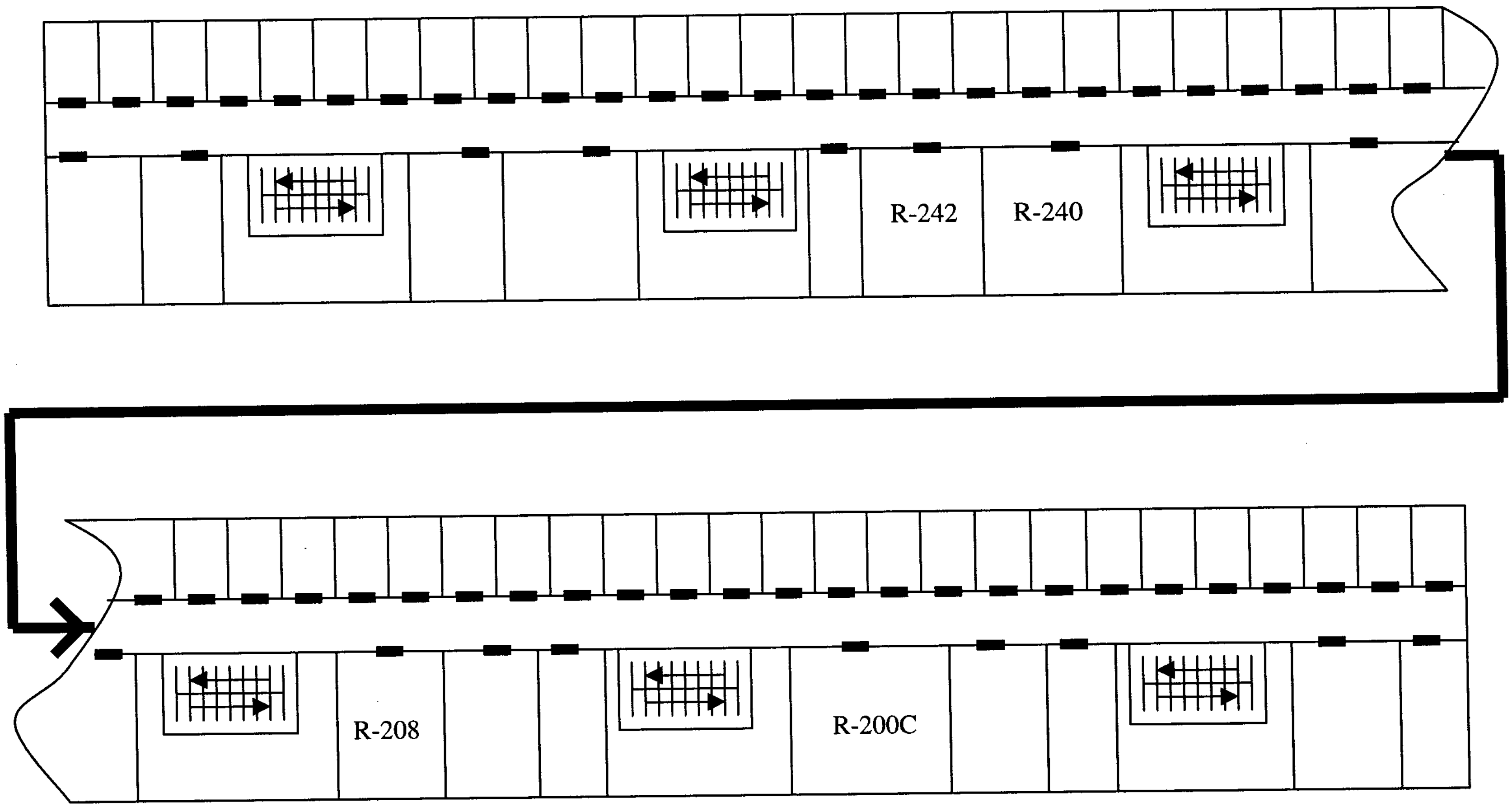


Ingersoll Hall - 2nd Floor



Ingersoll Hall - 3rd Floor


Mechanical Engineering Building
ME-138C
ME-143
ME-138
ME-144
ME-145
ME-150
ME-149
ME-147
ME-146
Mechanical Engineering
Auditorium



Root Hall - 2nd Floor

66th Military Operations Research Society Symposium

(66th MORSS)

Participant Evaluation — June 1998

The MORS Board of Directors and Symposium Staff want to improve MORS symposia to better respond to your needs and to improve the quality of military operations research. Your evaluation is very important and your comments will be considered in planning future events. Please complete this questionnaire and return it to your Composite Group or Working Group Chair; the MORS Office in Room 122, Glasgow Hall; or mail it to MORS, 101 S. Whiting Street, Suite 202, Alexandria, VA 22304-3483; or fax it to (703)751-8171.

<u>Background Information</u>:

a. Name (optional) ____________________

b. What is your affiliation?

Military: USA ☐ USN ☐ USAF ☐ USMC ☐ USCG ☐

Civilian: USA ☐ USN ☐ USAF ☐ USMC ☐ USCG ☐

Other DoD ☐ FFRDC ☐ Joint/Unified Staff/Command ☐

Other Federal Government ☐ Academic ☐ Consultant ☐

Professional Services Firm ☐ Manufacturing Firm ☐

Other ____________________

c. Including this MORSS, how many MORSS have you attended? __________

d. Do you plan on attending the 67th MORSS at the United States Military Academy in West Point, New York, 22, 23, 24_ June 1999?

Yes ☐ Probably Yes ☐ 50/50 Chance ☐ Probably No ☐ No ☐

If no or probably no, why not? ____________________

Place 32 cent stamp here

Return to:

Military Operations Research Society

101 S. Whiting Street, Suite 202

Alexandria, VA 22304-3483

2. Evaluation of the 66th MORSS

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5
a. OVERALL, how do you rate the 66th MORSS in meeting your needs					
b. Please give your assessment of each SPECIAL SESSION (SS) you attend (print the session name in the blank) and then an overall assessment of the Special Sessions meeting you needs.					
(1) SS 1					
(2) SS 2					
(3) SS 3					
(4) SS Overall					
(5) How can Special Sessions be improved?					
c. Please give your assessment of each TUTORIAL SESSION you attend (print the tutorial name in the blank) and then an overall assessment of Tutorials meeting your needs.					
(1) MON afternoon - #1					
(2) MON afternoon - #2					
(3) Series tutorial; offered over 2-3 days					
(4) TUE					
(5) WED					
(6) THU					
(7) Tutorials overall					
(8) What do you think of the extended form of tutorials?					
(9) How can tutorials be improved?					

Additional comments and suggestions:

Additional comments and suggestions:

2. Evaluation of the 66th MORSS (cont.)					
	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5
d. Overall, how do you rate the POSTER SESSION in meeting your needs?					
e. Please give your assessment of each COMPOSITE GROUP (CG) Session you attend and then an overall assessment of the Composite Groups meeting your needs.					
(1) CG A – Strategic & Defense					
(2) CG B – Space/C4ISR					
(3) CG C – Joint Warfare					
(4) CG D – Resources					
(5) CG E – Readiness/Training					
(6) CG F – Acquisition					
(7) CG G – Advances in MOR					
(8) Composite Groups overall					
(9) How can CGs be improved?					
f. Please give your assessment of each WORKING GROUP (WG) Session you attend and then an overall assessment of the Working Groups meeting your needs. (Please specify the WG # in blank).					
(1) 1st WG Session-WG#					
(2) 2nd WG Session-WG#					
(3) 3rd WG Session-WG#					
(4) 4th WG Session-WG#					
(5) 5th WG Session-WG#					
(6) 6th WG Session-WG#					
(7) 7th WG Session-WG#					
(8) 8th WG Session-WG#					

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5
(9) Working Groups overall.					
(10) How can WGs be improved?					
g. Please give your assessment of the following other events and provide suggestions for improvement.					
(1) Mixer					
(2) Evening at the Aquarium					
(3) Suggestions/improvements					

3. Evaluation of MORS Symposia

a. How helpful to you are the MORS Symposia in the following areas?					
(1) Receiving help on a current project.					
(2) Learning about new data sources.					
(3) Learning about models/ techniques that you may use.					
(4) Meeting colleagues you can consult with in the future.					
(5) Becoming aware of new problems requiring analysis.					
(6) Broadening perspectives of military operations research.					
(7) Other (list) ____________					
(8) Overall, how can MORSS be improved to meet your needs?					

4. Evaluation of MORS Activities

a. How satisfied are you with the way MORS is being managed?					

4. Evaluation of MORS Activities (cont.)

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5
b. How helpful are the following MORS publications for you or your organization?					
(1) Monographs					
(2) *MOR* Journal					
(3) *PHALANX*					
(4) *MOR Analysts Handbook*					
c. How helpful are the following MORS activities for you and your organization?					
(1) MORS Symposium					
(2) Mini-symposia					
(3) Workshops					
(4) Colloquia					

d. Suggestions for further activities:	**Do Not Support**	**Support**	**Strongly Support**
(1) Hold more joint meetings with other professional associations.			
(2) Other (please specify)			
(3) Would you be willing to volunteer your time and effort to pursue any of these?			

5. Other Comments or Suggestions – please feel free to continue writing on the back or attaching additional sheet(s).

WG 1 – STRATEGIC OPERATIONS – Agenda

Chair: Capt Jeffrey D. Weir , USSTRATCOM
Cochair: Roberta Carlisle, ANSER
Cochair: William Bearden, ANSER
Advisor: Mr. Robert V. Gates, NSWCDD

Room: I-280

Tuesday, 0830 - 1030
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330-1500 - Optimizing Strategic Force Structure
Start III Force Structure Alternatives
Patrick J. Mckenna, USSTRATCOM

Strategic Force Structure Optimization Analysis
B. Godfrey, Dr. Michael E. Senglaub, Sandia National Labs

Wednesday, 0830-1000 - Modeling and Simulation of Strategic Forces
Network Interdiction Tool
LCDR Philip S. Whiteman, USSTRATCOM

Weapons Allocation Model (WAM)
Maj Mark A. Gallagher, Capt Jeffery D. Weir, USSTRATCOM

Wednesday, 1030-1200
Joint Session with WG 3 .... Room I-122
Sensor Fusion for the Strategic Warfighter
Functional Description of New Methodology for Battle Damage Assessment
Capt Thomas Clutz, USSTRATCOM and Dr. Steven Hill, NRO Data Fusion Facility

Ballistic Missile Launch Detection and Trajectory Prediction
Col Salvatore Alfano, Dr. David Finkleman, Dr. Roy Mitchell, Maj Jay Jacobsmeyer, NORAD and USSPACECOM

Modeling the Verification of the Comprehensive Nuclear Test Ban Treaty
R. G. Gough, M. W. Edenburn, L. S. Walker, R. R. Preston, Sandia National Laboratories

Wednesday, 1330-1500 - Force Structure Assessments
Strategic Planning in an Era of Reduced Force Sizes
Wendell B. Nix Dr. Philippe Loustanau, Anne Milewich, Systems Planning and Analysis, Inc

Strategic Defense Force Structure Assessments
Dr. Sam Ward, Dr. David Finkleman, Dr. Murray Dixson, StClair Hultsman, NORAD and USSPACECOM

Thursday, 0830-1000 - Quadrennial Defense Review
Deep Attack Weapons Mix Study (DAWMS)
LCDR Richard K. Hartman III, USSTRATCOM

Quadrennial Defense Review Alternative Force Assessment (ODR-AFA)
COL Wm. Forrest Crain, U.S. Army Concepts Analysis Agency

Thursday, 1030-1200 - Nuclear Weapons Stockpile Issues
Stockpile Life Extension Planning - Maintaining Our Nuclear Warheads
Maj Mark A. Gallagher, USSTRATCOM

Sizing the START III Stockpile
LCDR Richard K. Hartman III, USSTRATCOM

Thursday, 1330-1500 - Strategic Planning Issues
Height of Burst cut-off and other issues related to the Probability of Damage Calculator (PDCALC)
MAJ Rick Yaw, Defense Intelligence Agency

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... **Room I-122**

Tuesday, 1330-1500 - Optimizing Strategic Force Structure

Recent Strategic Nuclear Force Structure Analysis

Mr. Pat McKenna and LCDR Rick Hartman
USSTRATCOM /J533
901 SAC Blvd Suite 2E10
Offutt AFB, NE 68113-6500
(402)-294-1654/1652

Analysts at USSTRATCOM have done numerous strategic nuclear force structure analyzes in the last year. This presentation will focus on three: START I force structure, START III force structure, and the conversion of SSBNs to SSGNs.

For START I, several force structure options and their ability to meet targeting requirements will be presented.

For START III, the presentation covers numerous force options for 2500 and 2300 force levels and their ability to meet targeting requirements. Force options are highlighted for three different force characteristics: 1) survivability, 2) time sensitive, and 3) a balance between the two. In addition, issues which eliminate some force options from consideration will be discussed.

The U.S. Navy is considering converting SSBNs to SSGNs. The presentation focuses on the strategic implications if the SSGN submarines remain accountable under the START I, START II, and the START III treaties. Several force options for each treaty and their resulting targeting implications will be presented.

Strategic Force Structure Optimization Analysis

Mr. B. Godfrey, Mr. Michael E. Senglaub, Ph.D.
Sandia National Labs
PO Box 5800
Albuquerque, NM 87185
(505) 844-9244

A great deal of uncertainty surrounds issues associated with strategic nuclear forces. Strategic Complexity is due to, or aggravated by stochastic nature of the problem, force structure realignments, aging systems, the transformation of potential threats and the policies of strategic forces. A weapon system development effort resulted in a need for a capability to perform a broader spectrum of strategic analyses. The developing capability is based on a number of artificial-life technologies with multiple levels of optimization. This capability allows the analyst to determine optimal force structures and mixes across a spectrum of strategic conditions. The scenarios considered in these analyses include issues associated with START treaty levels and associated triad vs. Dyads considerations, weapon system development speculations, and mission projections. The A-Life algorithm possesses a facility to approximate tactical decisions and policy issues through the optimization "fitness functions". Sensitivity studies are being conducted to asses the importance of various strategic factors on system and mission objectives. At present, the algorithms do not posses a gaming aspect for considering issues associated with adversarial offensive and defensive actions. The optimization models could be layered into higher level game theory algorithms in an effort to add another level of fidelity to the strategic analyses. Current efforts involve the validation of the algorithms and the decision models associated with the optimization algorithms.

Wednesday, 0830-1000 - Modeling and Simulation of Strategic Forces

Network Interdiction Tool

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USSTRATCOM's Network Interdiction Tool (NIT) has been developed to provide man-in-the-loop analysis for the interdiction of complex systems having a network architecture. The objective of the NIT program is to leverage operations research techniques to advance critical elements of strategic planning and consequences of execution evaluation into the 21st century.

NIT's graphical user interface accepts assumptions, requirements, and objectives from the targeteer. Data is displayed through GOTS spatial data display software. To minimize intelligence data requirements, NIT utilizes a simple capacitated flow network model of systems. Target selection analysis under deterministic assumptions is aided by integer programming formulations solved by COTS software. Risk assessment and prioritization of weapon assignment is performed by Monte Carlo runs integrated with basic linear program formulations.

Weapon Assignment Model for Nuclear Analysis and Planning

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For nuclear force studies and treaty analyses, the defense community needs a model to evaluate alternative futures. USSTRATCOM is developing the Weapon Assignment Model (WAM) to target nuclear weapon systems against target installations for various prioritized goals and realistic constraints. This integer programming problem requires dealing with three nonlinear effects: the compounding effect of multiple weapons against complexes of installations, the target tie-up of ballistic missile multiple independent targets, and routing of bombers and cruise missiles. WAM accounts for these nonlinear effects by using decision variables to select from many preprocessed alternatives. While this approach leads to almost a million decision variables, we found that commercial solvers can solve this particular problem in a reasonable time.

USSTRATCOM intends to use WAM for United States nuclear force analysis and construction of the Red Integrated Strategic Operations Plan (RISOP)—which is a hypothetical Russian attack on the West. In addition, USSTRATCOM is going to evaluate whether this methodology can aid in preparing the United States nuclear war plans. This presentation will cover the project status and plans, model formulation including maintaining the alternative pools, and sample results.

Wednesday, 1030-1200

Joint Session with WG 3 Sensor Fusion for the Strategic Warfighter........................ Room I-122

Functional Description of New Methodology for Battle Damage Assessment

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The Global Positioning System (GPS) satellite program will continue after FY00 without the United States Nuclear Detonation (NUDET) Detection System (USNDS) Electro-Magnetic Pule (EMP) sensor. This briefing outlines a proposal for a new battlespace management method. This method uses non-nuclear survivable sensors to provide initial battle damage assessment to USSTRATCOM decision makers during a limited nuclear attack. The system's proposed architecture will provide USSTRATCOM's senior leadership with accurate nuclear event data after the USNDS EMP sensor is no longer capable of performing such a function.

Ballistic Missile Launch Detection and Trajectory Prediction

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This paper describes consistent approaches to inferring missile launch points, trajectories, and impact points with infra-red sensors. NORAD and USSPACECOM have overarching responsibility for detection of theater and intercontinental ballistic missile (T/ICBM) launches world-wide and disseminating that information to all affected theaters. The Directorate of Analysis is responsible for assuring the technical integrity of these missions. These responsibilities include developing new, independent approaches to consolidating data from diverse sources and assessing mission performance. During the past year, we have developed several new approaches for consistent missile warning data fusion. Applying the principles of Kalman Filters, we have developed an internally consistent way to fuse asynchronous, uncertain lines of sight from diverse sensors and to combine a series of observations from diverse sensors into an estimate of the target trajectory. This permits extrapolation back to launch to determine potentially unobserved launch locations and forward to impact. The crucial element is accommodating uncertainty in all satellite measurements. Our analyses have allowed us to explore tradeoffs between highly precise predictions with large uncertainty and less precise predictions with lower uncertainty. We have applied these techniques to a consistent fusion of independently reported impact point predictions. This provides forward users with a single, confident basis for decision making. We are evaluating these techniques against real world missile launches and will make them available for worldwide application on GCCS. We will also report a related investigation which compares the capabilities of airborne and space based sensors as well as collaborative use of both aircraft and satellites. Our analyses reveal tradeoffs among high and low altitude platforms that economize the inventory of each.

Modeling the Verification of the Comprehensive Nuclear Test Ban Treaty

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Approved Abstract not available at printing

<u>*Wednesday, 1330-1500 - Force Structure Assessments*</u>

Strategic Planning in an Era of Reduced Force Sizes

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This paper concentrates on target planning for submarine launched ballistic missile (SLBM) forces in an era of reduced numbers of SSBNs. At its peak, the US strategic submarine force was 41 ships. Now, the QDR and NPR have recommended a force of 14 TRIDENT II SSBNs, and there are economic and political pressures to reduce even farther. With decreasing numbers, the notion of "steady state" day-today numbers of platforms at sea and in range of targets becomes increasingly untenable. Large to moderate times off-line (during overhaul, for instance) and even minor perturbations to the schedule can cause significant oscillation in the number of platforms. The fewer the number of SSBNs, the larger the size of this effect.

Strategic targeting planning can account for this effect in one of two ways:

- Either by becoming much more adaptable in the selection of targets as the number of available weapons oscillates and as the location of the platforms changes; or
- By selecting targets based on a high confidence lower bound on available resources and targets in range.

We will show examples of achievable SSBN operating areas and target coverage and how those vary with time. Then, we will inject a few random perturbations into the schedule to illustrate how they might affect target achievability. How to select targets and target package commitments will be discussed under the two conditions above; *i.e.*, adaptable targeting vs. high confidence lower bound. We will discuss prompt targeting effectiveness and effectiveness with some time late.

Strategic Defense Force Structure Assessments

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This paper reports analyses of North American strategic air defense requirements and the models that support those analyses. The NORAD and USSPACECOM Directorate of Analysis is responsible for assessing courses of action for North American strategic air defense and air sovereignty. Our NORAD Air Defense Model (NADM) represents current rules of engagement, allocated force structure, and the performance characteristics of all sensors and engagement systems. The air breathing threat to North America spans the spectrum from the current Russian bomber inventory through individual light aircraft delivering contraband to future stealthy air breathing cruise missiles. Our analyses encompass all of these threats. We will describe the model, the characteristics of sensors, aircraft, and other engagement systems, and rules of engagement. We will discuss the capabilities of current forces and examine the sensitivity of the defense to the capabilities of those forces. The paper culminates by describing our analytical support to the recent Global Guardian exercise and our contributions to revisions of future operational plans.

<u>*Thursday, 0830-1000 - Quadrennial Defense Review*</u>

Deep Attack Weapon Mix Study (DAWMS)

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Quadrennial Defense Review Alternative Force Assessment (ODR-AFA)

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The purpose of the QDR-AFA was to examine the Office of the Secretary of Defense (PA&E) analytic framework for comparing alternative force structure options and introduce additional force structure alternatives which were based on the operational requirements of specific theaters of operation.

Specific objectives accomplished in this study were: 1. A comparison of the OSD Force Structure Alternatives and a doctrinal, situationally based force alternative in terms of operational effectiveness and cost using the Deep Attack Weapons Mix Study (DAWMS) as the base case. 2. Development of a template (response surface mapping) which illuminates alternative joint force structures required to minimally accomplish each campaign phase; map known force assessment alternatives onto the template; and use the template as a predictive tool for rapid evaluation of Dual-Major Theater War (MTW) force structure alternatives during the QDR. 3. Develop an historical template for estimating Smaller Scale Contingency (SSC) force requirements. Add SSC and expected dual MRC force requirements to gain insights to the total force requirements.

The results of this study identified an alternative force which not only achieved the dual MTW national military strategy, but cost less than those OSD alternatives under consideration. This force alternative provided the Department of the Army's and subsequently the Department of Defense's final position in the QDR.

Thursday, 1030-1200 - Nuclear Weapons Stockpile Issues

Stockpile Life Extension Planning - Maintaining Our Nuclear Warheads

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With the end of the Cold War, the United States changed from producing nuclear weapons to maintaining (while reducing) our current nuclear stockpile. This presentation reports on the results of a cursory study of repair schedules and necessary maintenance infrastructure. Furthermore, the study proposes criteria to select among alternative modification proposals.

Sizing the START III Stockpile

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Approved Abstract not available at printing

Thursday, 1330-1500 - Strategic Planning Issues

Height of Burst cut-off and other issues related to the Probability of Damage Calculator (PDCALC)

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Approved Abstract not available at printing

WG 2 – NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE – Agenda

Chair: Ms. Debbie Lott, USANCA
Cochair: Maj Jim Demyanovich, USANCA
Cochair: Mr. Miles Miller, US Army ERDEC, APG
Advisor: Mr. Doug Schultz, Institute for Defense Analysis
Room: I-282

Tuesday, 1030 – 1200
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330 – 1500
Joint Weapons of Mass Destruction Analysis
Lieutenant Colonel Victor Young, Joint Staff, Pentagon

Analysis of IR Radiometer Data from Bulk Chemical Impact Test #16
Dr. Martin B Richardson, Teledyne Brown Engineering

Wednesday, 0830 – 1000
Khamisiyah Plume Analysis: March 10-13, 1991
Dr. Richard Babarsky, Office of the Special Assistant for Gulf War Illnesses

Assessing Chemical Detector Effectiveness using Distributed Simulation
Richard McMahon, Larry Nagl, Miles Miller, U. S. Army Research laboratory, ERDEC

Wednesday, 1030 – 1200
A Vulnerability Assessment Tool for Air Base Operability in Chemical and Biological Warfare Environments
Thomas J. Sterle, Simulation Technologies, Inc.

New Concepts and Heightened Sensitivities Regarding NBC Threats
Ms. Veronique Hauschild, USACHPPM

Wednesday, 1330 – 1500
Algorithm for Simulation of Background Aerosols
Michael O. Kierzewski, OptiMetrics, Inc.

Biological Detection System Modeling and Simulation
Dr. SY Shey, MIT Lincoln Laboratory

Thursday, 0830 – 1000
Development of Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Battle Casualties, Volume 2: Biological
Julia Klare, Institute for Defense Analyses

Biological Agent Effects and Degraded Human Performance
George Anno, Pacific-Sierra Research Corp

Thursday, 1030 – 1200
Backtrack, A Hybrid System for Predicting the Source of a Biological Attack from Sensor Data
Michael J. Smith, ERDEC, Michael B. Esposito, ITT Systems and Sciences Corporation

Application of NBC Modeling and Simulation Techniques to Consequence Management Hazard Prediction
Thomas S. Stark, Defense Group Incorporated

Chemical and Biological Terrorism: Not Just Another Battlefield
Gary Eifried, Col (Ret), EAI Corporation

Thursday, 1330 – 1500
Measures of Effectiveness for the Deployment of Biological Sensors
Nathan Platt, Institute for Defense Analyses

Man in Simulant Test (MIST)
James A. Hanzelka, U.S. Army Dugway Proving Ground

Backup Presentations:

Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats
Tom McIlvain, TASC

Understanding the Current Protection and Decontamination Methods after a Potential Biological Attack – An Assessment
Chittoor K. Ramachandran, PhD, U.S. Army Dugway Proving Ground

WG 2 – NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE – Agenda
Room: I-282

Tuesday, 1030 – 1200

COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330 – 1500

Joint Weapons of Mass Destruction Analysis

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In Jan 96, the Joint Requirements Oversight Council (JROC) requested J4 look at medical requirements, and J8 look at the use of WMD on the 2 Major Theater of War (MTW) warfight. This requirement resulted in a diverse Working Group (WG) under the direction of a J-8/J-4 led General Officer Steering Group (GOSG). This initial 18 month study effort culminated in a final briefing to the JROC and other senior service panels in June 97. The analysis helped influence increased DoD spending in Counterproliferation and Chemical-Biological Programs

This presentation will provide a summary of the follow-on work which refined the original analysis. The GOSG asked the WG to conduct sensitivity analyses which varied key assumptions such as sortie degrades, ground MOPP degrades, and warning times. This effort incorporated a collaborative use of low and high resolution models. TACWAR was used as the campaign modeling tool with inputs from MIDAS(flow of forces), EADSIM(TMD effects) and a variety of downwind hazard prediction models.

Analysis of IR Radiometer Data from Bulk Chemical Impact Test #16

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The Hit-to-Kill Bulk Chemical Impact Test series, sponsored by BMDO as part of the Joint Missile Defense Lethality Program, was conducted during 4Q FY97 to investigate the amount of bulk chemical agent that could be negated in a hit-to-kill impact. During Test #6, conducted on 12 August 1997, Army Research Laboratory (ARL) determined cloud temperature as a function of time for the first 0.44 sec from mid-IR radiometer imagery data.

Teledyne Brown Engineering employed the ARL cloud temperature history (up to the time of the hot propellant gas impingement at 0.36 sec) to compare against calculated cooling times for isolated spherical droplets with diameters ranging from 100 to 5000 µm in order to gain insight into whether a particular cooling mechanism dominated and whether the data was consistent with a particular drop size.

Two cooling mechanisms, radiative and conductive, were investigated (a third, evaporative, was not considered owing to the very low volatility of TBP). For the radiative cooling calculations, it was assumed that the droplet behaved like a black-body. For the conductive cooling calculations, heat was assumed to be conducted from the droplet surface into the boundary layer of air surrounding the droplet. Finite droplet conductivity was ignored (which, as it will be shown, has only a minor effect on the results).

The theoretical results show that, for these particular test conditions, the conductive cooling rates are orders of magnitude more efficient than the radiative cooling rates.
A comparison of the theoretical cooling curves with the derived cooling curve indicated that the theoretical cooling rate for a 1 mm drop most closely follows the derived cooling rate.

These results have implications for high altitude bulk chemical releases. In addition, the successful application of the radiometry data indicates the potential usefulness of passive radiometry for lethality and kill assessment data acquisition.

Wednesday, 0830 – 1000

Khamisiyah Plume Analysis: March 10-13, 1991

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From fall 1996 to fall 1997 a DoD/CIA task force ,which consists of modeling groups from NRL, NSWC, DSWA, NCAR, and SAIC, has been engaged in an intensive effort to develop predictions of the potential chemical fallout from the March 1991 open-pit demolition operations at Khamisiyah in southern Iraq. The DoD/CIA team has analyzed previously classified data on the munitions involved and performed experiments to determine the type and quantity of agent released as well as its evaporative time history (the mechanism of release of the chemical agent contained in the rockets at Khamisiyah is a strong factor in driving the dispersion patterns which characterize the release). The team has also been engaged in a major effort to reanalyze the weather, including local-scale circulations important for this problem., using all meteorological data, including recently declassified data, and the highest resolution atmospheric forecast tools available. The Khamisiyah detonation plume dynamics are dominated by planetary boundary layer transport and models used in this analysis all include detailed treatments of the PBL which result in a realistic representation of the transport and deformation of the agent cloud. Finally, the DoD/CIA team has also used an "ensemble" approach in which different models were used to reconstruct the meteorology (COAMPS, MM5, OMEGA) as well as disperse the agent (VLSTRACK, SCIPUFF, NUSSE4).

Several in-theater personnel databases were used in conjunction with the downwind dispersion model simulations to determine unit locations and their potential exposure from the Khamisiyah pit demolition.

Assessing Chemical Detector Effectiveness using Distributed Simulation

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Developers, testers, and trainers of chemical and biological (CB) defense equipment are saddled with the difficulty of operating in a realistic environment. This paper describes a recent two day pilot study conducted to determine how to use distributed simulations in engineering and doctrine studies of CB defense material. A secondary objective was to generate useful quantitative data for application to the Joint Service Lightweight Chemical Agent Standoff Detector (JSLSCAD),

The study used two different chemical agent standoff detector simulations, the aforementioned JSLSCAD and the fielded M21 Remote Standoff Chemical Agent Alarm. The detectors operated as part of a man-in-the-loop simulation of a chemical reconnaissance vehicle. The vehicle crew conducted a route reconnaissance mission in conjunction with a ModSAF-supplied M2 security force. Chemical agent was disseminated across the battlefield using the Nuclear, Chemical, Biological, and Radiological Simulator. We developed four mission profiles varying terrain and meteorological conditions. The crew conducted each mission twice; alternating detector simulators, for a total of eight missions over two days.

We collected quantitative and qualitative performance data for the study using network logs and video. Mission timeline data were collected and suggested substantially faster mission timelines using JSLSCAD. We observed results in chemical agent cloud movement, suggesting the potential for simulation to aid engineering and TTP studies.

Experimental control and adequate data collection planning were two important lessons learned for future application. The necessity to treat simulation as a live test was striking, and provides a useful framework for developing future simulation study and test plans.

Wednesday, 1030 – 1200

A Vulnerability Assessment Tool for Air Base Operability in Chemical and Biological Warfare Environments

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A Vulnerability Assessment Tool (VAT) was developed to allow Air Force commanders and planners to make informed decisions on the operability of air bases in chemical and biological warfare (CBW) environments and to identify the most critical components of a defensive capability. The VAT is a series of tables containing predicted sortie and casualty levels for 2,070 combinations of theater, base size, time of year, attack scenario, and defensive capability/strategy. An existing high-resolution, Monte Carlo, discrete-event simulation model of combat sortie generation was used to obtain the predictions after detailed methodology development and input/case definition to accurately represent the CBW environment and CBW defensive capability on a USAF air base. CW agent liquid and vapor and BW agent aerosol challenge histories are defined at each of approximately 2,000 uniformly-spaced air base locations for a number of multiple-attack scenarios of either 5 or 7 days, using a single-release dissemination model and a probabilistic multiple-release pattern overlay model. After an initial screening phase five defensive components were selected for representation: long-term collective protection (available or not), protective suit (standard vs. lightweight), personnel intermittent cooling (available or not), de-warning strategy (various schemes), and expedient equipment decontamination (performed or not). The selections were based on the expectation of significant variability in operational availability or implementation and suitability for simple but credible representation in the air base simulation.

New Concepts and Heightened Sensitivities Regarding NBC Threats

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Deployed United States personnel can be exposed to toxic chemicals in air, soil, and water through inhalation, ingestion, or skin contact, with significant immediate effects, i.e., disease and non-battle injury (DNBI) and performance degradation, or prolonged health effects. The military and civilian concerns have shifted to the Nuclear, Biological, and Chemical (NBC) arena, as demonstrated by the continuing investigations of the undiagnosed Persian Gulf War Veterans' illnesses since 1991, to include the questions related to the exposure to the NBC contamination.

The Army Medical Department has initiated efforts to proactively address the potential health effects to deployed soldiers. This initiative includes enhanced medical and environmental exposure surveillance, to help establish the cause (environmental exposures) and effect (medical outcome) relationships. Evaluation of the air, water, and soil analytical data collected in support of the Bosnia Operations Joint Endeavor and Joint Guard (including military unique chemical agents and compounds as well as toxic industrial chemicals) includes a risk assessment by highly trained environmental/health risk assessors at the USACHPPM. The assessment process is, however, hindered by the lack of pre-established guidelines or standards, applicable to deployments. Federal guidelines and standards (e.g., the Environmental Protection Agency standards) used for risk assessments are more appropriately applicable to protect workers and/or the civilian public for lifetime exposures, and are not directly applicable to the deployed personnel. To overcome this serious limitation, the USACHPPM is developing deployment-specific guidelines. Two technical guides (TGs) are under development that will provide information for short-term (up to two weeks) and long term (> 2 week, up to 1 year) exposures. The TGs will address potential performance degradation and health effects associated with exposures exceeding certain concentrations. Additionally, they will be used to determine field sampling and analytical capabilities and procedures.

Wednesday, 1330 – 1500
Algorithm for Simulation of Background Aerosols

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Simulations to assess the effectiveness of developmental biodetection equipment and systems have routinely neglected the "noise" presented by naturally occurring background aerosols. This is understandable because the majority of weapon s effects models were designed to assess casualties not represent the complete environment a potential sensor would face. As simulation is used to supplement and guide field testing, it is becoming imperative that the simulations accurately re present the complete environment in which a sensor will have to function.

One method has been to use canned sets of actual data from field monitoring for the background aerosols. While accurate, this method of considering the background lacks flexibility and requires all the data points from each site to b e stored in the computer in their entirety.

This paper presents a modified random walk algorithm for simulating background aerosols and discusses refinements to the data collection and simulation of background aerosols. The behavior of the simulation is compared to measured aerosol counts for various locations. Methods to increase the fidelity of the simulation are presented and their effects demonstrated.

Biological Detection System Modeling and Simulation

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A challenge in preparing for military operations in the 21st Century is the proliferation of weapons of mass destruction. Chemical and biological weapons may be used by our adversaries in an asymmetrical response to our strength in conventional and nuclear arms. They threaten our soldiers in the field and Americans at home.

This presentation reports on recent results from three analysis activities at Lincoln Laboratory in support of the development and evaluation of an integrated biological detection system for surveillance and early warning.

Analysis of simulation results will be shown for a defensive scenario to illustrate the performance requirements for a system of biological detectors. The results will be presented in terms of defense parameters such as the number of detectors, detector sensitivity, integration time, system alarm criterion, and system delay. The results illuminate the relative payoffs in improving sensor system performance and the assumptions in effectiveness criteria.

Second, the analysis of field measurements of a Bio-Aerosol Fluorescence Sensor designed and developed at Lincoln Laboratory will be described. The results will be presented in terms of detector sensitivity and signal and background statistics for different integration times. The results represent the state-of-the-art in biological detection.

Third, a simulation combining the results from the two activities above will be shown providing an animated visualization of the features of an example of integrated biological detection system. Videotape of the laptop computer demonstration will be presented. These results show the potential power of modeling and simulation tools (especially when implemented and tested in Chemical and Biological Distributed Simulation Suite) to facilitate communication between developers and users and to help in defense acquisition.

Thursday, 0830 – 1000

Development of Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Battle Casualties, Volume 2: Biological

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In its role as U.S. representative to the NATO NBC Medical Working Party, the Office of the Army Surgeon General (OTSG) has initiated development of a series of NBC casualty estimation manuals. These manuals, covering nuclear, biological and chemical casualties, are designed to update and expand Allied Medical Publication 8 (AMED P-8), a manual for estimating casualties of nuclear attacks last published by NATO in the early 1960s. The purpose of these manuals is to provide medical planners with worst-case estimates of expected casualties over time under a range of operational scenarios. They consider variations in unit formation, meteorological conditions, agent and weapon system. AMED P-8 Biological is the most ambitious document in the series; it will include more agents and more varied operational scenarios than either the nuclear or chemical volumes.

Volume 1 in this series, AMED P-8 Nuclear, is now under ratification review by NATO member nations; the U.S. recently provided NATO with Study Draft 3 of Volume 3, AMED P-8 Chemical. Having developed the format and content of the series with the nuclear casualty manual, IDA is now working with SAIC and Pacific-Sierra Research Corporation to complete the remaining chemical and biological volumes. This effort relies heavily on our indigenous casualty estimation methodologies and the operational expertise of the IDA staff to generate operational scenarios and to estimate the number of troops exposed in each.

Biological Agent Effects and Degraded Human Performance

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Technical background and research is described to quantify the human response to biological agents that could be released as a weapon by an adversary in the form of respirable aerosol. The objective of the research was to quantify the pathophysiological effects following the inhalation of bioagent pathogens by developing mathematical models to estimate the severity of illness and corresponding degrading effects on human performance.

Human data from clinical records, including cases of accidental exposures, infection acquired naturally in the environment, and controlled intentional exposures were utilized. The intentional exposures involved military research volunteers (MRVs) during controlled studies largely involving the development of vaccines and antibiotic therapy testing in the mid 1950s to late 1960s time-frame. This enabled temporal human response data to be correlated with inhaled pathogen dose, the basis for the development of the semi-empirical response algorithms described in this study.

Three different bioagent-induced illnesses (tularemia, staphylococcal enterotoxin B toxicity, and Q-fever) are presented to illustrate the development of modeling parameters. Each of the three are febrile diseases, characterized by a body temperature profile and accompanying signs and symptoms. Utilizing body temperature and objective test measurements of the corresponding effects on cognitive and physical performance, algorithms were developed that can be used to estimate the probability of infection and the dynamical extent of performance degradation as a function of dose and post-exposure time. The response models developed provide a means of assessing the consequences to military operations or civilian activities when coupled with atmospheric dispersion algorithms to simulate a bioagent release to the environment.

Thursday, 1030 – 1200

Backtrack, A Hybrid System for Predicting the Source of a Biological Attack from Sensor Data

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Backtrack is a hybrid artificial intelligence (AI) system that identifies the source location of a biological agent attack from sensor data. Under FY97 funding provided by the Joint Program Office for Biological Defense (JPO BD), the Edgewood Research Development and Engineering Center (ERDEC) Modeling and Simulation (M&S) Team developed this tool to complement a biological agent detection and warning capability being developed for high value, fixed sites, such as ports and airfields. Backtrack employs both expert (i.e., rule-based) and artificial neural network (ANN) technologies to arrive at its source location predictions. The system is site-specific in that the ANN encapsulates knowledge of three-dimensional terrain and the associated complex wind field for a specific area. Inputs to the system include current meteorological conditions, sensor location, sensor alarm status, and sensor particle count over time.

The FY97 effort Backtrack effort demonstrates the feasibility of the basic concept. The current system uses training data based on linear releases of a biological agent to predict the location of the attack by specifying the center of the line source. In 1998, we propose to extend Backtrack by adding the capability to address point source biological threats, an increased range of atmospheric stability conditions, and chemical threats. In 1999, we propose to test the improved Backtrack system in a Joint Field Trial (JFT) or similar test series.

Backtrack is a capability that would ultimately serve as a component/module of the Joint Warning and Reporting Network (JWARN) system.

Application of NBC Modeling and Simulation Techniques to Consequence Management Hazard Prediction

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An important part of the Nuclear, Biological and Chemical (NBC) Defense mission is the modeling of NBC hazards, their propagation, and resulting effects. In recent years, a number of models have been developed to consider NBC hazard prediction in battlefield conditions. Generally, these models consider outdoor release of NBC agents, and take into account meteorological conditions, simple terrain features, and an identified source term. In this presentation we describe the goals, methods, and conclusions of a Modeling and Simulation Study, conducted as part of the Consequence Management 911-BIO Advanced Concept Technology Demonstration (ACTD). The general purpose of this study was to apply hazard prediction techniques to consequence management scenarios. In the context of this ACTD, consequence management involved the analysis and mitigation of hazards affiliated with a bio-aerosol release inside and near buildings in a domestic urban environment. Since the DoD's current hazard prediction capability is limited to outdoor effects, this study had to be conducted with a set of models that were originally developed for other purposes, but adapted for hazard prediction calculations. The set of models was used to predict the time-varying concentration of bio-aerosol simulant in a set of buildings, and the predicted results were compared with ground truth measurements. While the results allowed broad conclusions to be drawn about the applicability of different model-types to indoor hazard prediction problems, they also allowed the compilation of some 'rules of thumb' for hazard prediction in and around buildings. These rules of thumb can be used before turning to formal computer simulations, or when complexity, time, and resource constraints do not allow for the use of hazard prediction models.

Chemical and Biological Terrorism: Not Just Another Battlefield

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The horrific potential of a terrorist using a weapon of mass destruction (WMD) has become a priority concern of the federal government. Over $92.5 million was allocated to the DOD in 1997 to provide WMD response support to state and local agencies. A recent Defense Science Board study concluded that the DOD should focus more on the risk of WMD attacks on the U.S. To date, over 6,000 public safety agency personnel (firefighters, hazardous materials specialists, police, medical personnel) have been trained and participated in response exercises. A key finding of these activities is that battlefield doctrine, equipment and procedures can only serve as a start point for establishing

a response to domestic WMD terrorism. The threat and level of acceptable risk are different than for the battlefield. On the plus side, public safety agencies already have some capability to respond to mass casualty disasters and release of toxic materials. Thus, equipment and procedures used in responding to WMD terrorism must take into account the existing capabilities of response agencies, the criteria and requirements evolving from the threat, the degree of risk which will be tolerated, the mass casualty implications and the considerations of a crime scene. This paper highlights the factors which must be considered when developing scenarios and conducting analyses of WMD terrorism. The comparison between battlefield and civil operating systems will serve as a benchmark for operations researchers in applying current NBC defense tools to problems of WMD terrorism.

Thursday, 1330 – 1500
Measures of Effectiveness for the Deployment of Biological Sensors

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Biological weapons are capable of producing devastating casualties among unprotected populations, and are relatively easy and inexpensive to produce. The detection of biological agents and protection of troops and facilities pose great challenges for military organizations. Presently, there are a number of biological sensors available for the detection of various agents. Accordingly, there is a logical need to determine the least-cost type and number of sensors required to achieve selected levels of protection. In the past, a "look-and-squint" method was used to evaluate casualties on a map as a measure of effectiveness (MOE) for a given deployment of sensors. Clearly, this method is very subjective, and optimal numbers of sensors vary with the people doing the "squinting". Thus, there is a need to develop good, objective measures to evaluate various sensor deployments.

We will examine at least two approaches for evaluating biological sensors deployed around fixed installations and moving troops. One approach takes into account various levels of intelligence for an opponent, and produces reactive MOEs for deployments of sensors. It uses an "opponent intelligence parameter" to assign probabilities to the aim points ordered (from highest to lowest) by the casualties resulting from undetected attacks. A second approach takes into account percentages of "casualty-weighted" area, and produces static MOEs for arrangement of sensors. It uses attacks with no sensors deployed to produce a basic weighted-casualties list, and then it calculates the fraction of attacks being detected by the deployment of sensors. The benefits and the shortcomings of each approach will be investigated.

Man in Simulant Test (MIST)
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There has long been a need to develop a process to evaluate the protective capability of chemical protective clothing as worn by the soldier in the field. U. S. Army Dugway Proving Ground (DPG), in concert with several other government laboratories, has developed a process that meets the requirements of providing a test of chemical clothing in a vapor environment, while subjecting the clothing to the stress experienced during wear. The development of the process, results of testing in the U. S. and some experiences with international testing with the Canadian will be discussed.

Backup Presentations:

Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats
Tom McIlvain, Walter Estrada
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As DoD budgets decline, depots are closed, and forces are reduced, the warfighter's reliance on large DoD inventories must be replaced by greater dependency on direct commercial supply sources. In this new environment, full war/contingency material support readiness assessment can no longer be considered complete or realistic unless it includes an assessment of commercial sources.

In addition, future scenarios are more likely to involve non-conventional threats, such as nuclear, biological, and chemical (NBC) weapons. Also referred to as Weapons of Mass Destruction (WMD), their name suggests a potential reality, that these weapons can produce large numbers of casualties in a single attack. The numbers of casualties produced may significantly strain the medical logistics system over and above conventional plans. This will raise new, perhaps even unique issues of medical resource forecasting.

Understanding the Current Protection and Decontamination Methods after a Potential Biological Attack – An Assessment

Chittoor K. Ramachandran, PhD, Life Sciences Test Facility, WD-L-T, U.S. Army Dugway Proving Ground, Dugway, UT 84022-5000
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WG 3 - ARMS CONTROL AND PROLIFERATION - Agenda

Chairs: Major Joe Hogler, USSTRATCOM J512 & Mr. Pat McKenna, USSTRATCOM J533
CoChair: Robert Tomes, J-5/CAC (ANSER)
CoChair: Major Lynne Baldrighi, HQ USAF/XONP
CoChair: John W. Drye, SPA, Inc.
Advisor: Dr. Robert Batcher, ACDA
Room: I-285

Tuesday, 1030 – 1200
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330-1500
Some Potential Risks at Lower Levels of Strategic Nuclear Weapon Arsenals
Fred Nyland, U.S. Arms Control and Disarmament Agency

Strategic Planning in an Era of Reduced Force Sizes
Wendell B. Nix, Philippe Loustanau, PhD and Anne Milewich, Strategic Planning and Analysis, Inc.

Wednesday, 0830-1000
Conventional Forces in Europe (CFE): Treaty Elements, Adaptation Issues and Analytical Questions
Dorn Crawford, U.S. Arms Control and Disarmament Agency

CFE and Military Stability in Europe
John E. Peters, RAND

Quantitative Analysis on the Utility of Antipersonnel Landmines (APL)
Captain Kevin J. Vink and H. Colleen Lewis, U.S. Army Concepts Analysis Agency

Wednesday, 1030-1200
JOINT SESSION WITH WG 1 .... Room I-122
Sensor Fusion for the Strategic Warfighter
Functional Description of New Methodology for Battle Damage Assessment
Capt Thomas Clutz, USSTRATCOM

Ballistic Missile Launch Detection and Trajectory Prediction
Col Salvatore Alfano, Dr. David Finkleman, Dr. Roy Mitchell, Maj Jay Jacobsmeyer, NORAD and USSPACECOM

Modeling the Verification of the Comprehensive Nuclear Test Ban Treaty
R. G. Gough, M. W. Edenburn, L. S. Walker, R. R. Preston, Sandia National Laboratories

Wednesday, 1330-1500
Munition Destruction Statistics for the Chemical Weapons Convention
Bob Batcher, U.S. Arms Control and Disarmament Agency

Chemical Assistance Program
Jean Razulis, U.S. Army CBDCOM Treaty Verification

Man in Simulant Test (MIST)
James A. Hanzelka, U.S. Army Dugway Proving Ground

Thursday, 0830-1000
21ST Century Negotiations: Epilogue for Strategic Agreements?
James E. Burke, TASC

State-of-the-Art Information Technologies and Their Impact on Future Arms Control
Lawrence S. Wolfarth and William A. Scanlon, Litton-TASC

Thursday, 1030-1200
Nuclear Scenarios for the Post-Cold War Era
James Scouras, Strategy Research Group

Theater Missile Defense and the ABM Treaty
Lt Col Craig Rowdon, LCDR Doug Woodring, and MAJ Rick Yaw

Planning the Unthinkable: New Proliferators and WMD Use Doctrines
James Wirtz, National Security Affairs, Naval Postgraduate School

WG 3 - ARMS CONTROL AND PROLIFERATION – Abstracts
Room I-285

Tuesday, 1030 – 1200
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330-1500
Some Potential Risks at Lower Levels of Strategic Nuclear Weapon Arsenals
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This paper presents a discussion and analyses of some risks that might be encountered if both the U.S. and Russia were to reduce their strategic nuclear weapon inventories in future arms control environments. The potential risks include: the diminution of strategic nuclear deterrence, susceptibility to sudden attack with launch on warning response, and the implications of cheating or break-out in terms of numbers of weapons on either or both sides. The limits on strategic nuclear weapons for both sides include the proposed START III level of 2000-2500 weapons, and a lower potential limit of 800 strategic nuclear warheads.

Strategic Planning in an Era of Reduced Force Sizes
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This paper concentrates on target planning for submarine launched ballistic missile (SLBM) forces in an era of reduced numbers of SSBNs. At its peak, the US strategic submarine force was 41 ships. Now, the QDR and NPR have recommended a force of 14 TRIDENT II SSBNs, and there are economic and political pressures to reduce even farther. With decreasing numbers, the notion of "steady state" day-today numbers of platforms at sea and in range of targets becomes increasingly untenable. Large to moderate times off-line (during overhaul, for instance) and even minor perturbations to the schedule can cause significant oscillation in the number of platforms. The fewer the number of SSBNs, the larger the size of this effect.

Strategic targeting planning can account for this effect in one of two ways:

- Either by becoming much more adaptable in the selection of targets as the number of available weapons oscillates and as the location of the platforms changes; or
- By selecting targets based on a high confidence lower bound on available resources and targets in range.

We will show examples of achievable SSBN operating areas and target coverage and how those vary with time. Then, we will inject a few random perturbations into the schedule to illustrate how they might affect target achievability. How to select targets and target package commitments will be discussed under the two conditions above; *i.e.*, adaptable targeting vs high confidence lower bound. We will discuss prompt targeting effectiveness and effectiveness with some time late.

Wednesday, 0830-1000
Conventional Forces in Europe (CFE): Treaty Elements, Adaptation Issues and Analytical Questions
Dorn Crawford
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Since the signing of the CRE Treaty in November 1990, the transformation of European security it embodies has proceeded apace, though certainly not without lingering difficulties and challenges. The 34 nations convened there under the auspices of the Conference on Security and Cooperation in Europe, or CSCE are now 55; the 22 original parties to the CFE Treaty, signatories of either the erstwhile Treaty of Warsaw or the North Atlantic Treaty, are now 30. The unprecedented reduction of conventional armaments in the region has been largely completed. CSCE is now the Organization on Security and Cooperation in Europe, or OSCE.

The CFE Treaty is highly complex undertaking of twenty-three articles and associated protocols, with the full English text running to

some 110 pages. Associated reports, notifications, and information exchanges to date already yield ample new metaphors to enrich our concept of an 'information explosion'. This overview is self -conscious effort to distill and simplify the central aspects of the Treaty and associated documents, focusing on aggregate equipment and manpower limits, holdings, and sites. With Treaty adaptation under active discussion, and enlargement of NATO a closely related prospect, analytical questions of the resulting 'balance' and 'military sufficiency' have returned in far more complicated forms.

The analytical task this effort represents is a familiar one: seeking adequate measures of effectiveness that economically convey the main thrust of the phenomena observed, and then using them for analytical tasks. Trading off simplicity against precision, concept against comprehensiveness, are at the heart of scientific inquire, and adequate oversight of a major arms limitation treaty should certainly meet that standard. Reviewing and discussing means and measures employed in this pursuit should thus be of interest to analysts as well as policy makers.

The evident premise of this work remains the old but still operative bromide that holds a picture to be worth a thousand words. The object is to use a handful of graphics and accompanying narrative on the key features of the CFE regime as a vehicle to inform discussion of issues of continuing interest as Treaty implementation is concluded and long term adaptation begins.

CFE and Military Stability in Europe

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Approved Abstract not available at printing.

Quantitative Analysis on the Utility of Antipersonnel Landmines (APL)

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Approved Abstract not available at printing.

Wednesday, 1030-1200

JOINT SESSION WITH WG 1 .... Room I-122

Functional Description of New Methodology for Battle Damage Assessment

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Ballistic Missile Launch Detection and Trajectory Prediction

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Approved Abstract not available at printing

Modeling the Verification of the Comprehensive Nuclear Test Ban Treaty

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Wednesday, 1330-1500

Munition Destruction Statistics for the Chemical Weapons Convention

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The Chemical Weapons Convention (the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction) is a global treaty banning the production, acquisition, stockpiling, transfer and use of chemical weapons. As part of this treaty, existing stockpiles of munitions, including those in the United States, must be destroyed. The process of destruction requires monitoring and verification through detailed assessments of the items as they are being destroyed. Because such assessments are costly in terms of money, time, and hazard risk, sampling of the items being destroyed is required. This paper describes the statistics appropriate to this sampling process and applies them to the stockpile enumerated in the U.S. declaration.

Items of a single class of munitions to be destroyed can number in the hundreds of thousands. A sample of these munitions is to be checked for violations (i.e., the contents do not conform to the U.S. declaration) as they are being destroyed. If we insist on a high probability of detecting just a few violations in such a large population, prohibitively large sample sizes would be required. However, if one starts with a range of feasible sample sizes, examination of the "power curves" associated with each sample size demonstrates that detection probabilities that are more than adequate for deterrence are attainable at surprisingly low concentrations of violating items; further, at somewhat higher concentrations, detection becomes almost certain.

Chemical Assistance Program

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Man in Simulant Test (MIST)

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Thursday, 0830-1000

21ST Century Negotiations: Epilogue for Strategic Agreements?

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Approved Abstract not available at printing

State-of-the-Art Information Technologies and Their Impact on Future Arms Control

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Thursday, 1030-1200

Nuclear Scenarios for the Post-Cold War Era

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Approved Abstract not available at printing

Theater Missile Defense and the ABM Treaty

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Approved Abstract not available at printing

Planning the Unthinkable: New Proliferators and WMD Use Doctrines

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Approved Abstract not available at printing

WG 4 - AIR AND MISSILE DEFENSE

Chair: Robert Fleitz, Coleman Research Corp.
Cochair: Mike Ellis, Quantum Research
Cochair: Fred Jerding, Systems Planning and Analysis, Inc.
Cochair: Sharon Noll, IDA/POET
Cochair: Tom Pendergast, HJ Ford Associates
Cochair: Bob Strider, USASMDC
Cochair: Paul Tabler, S3I
Advisor: Beverly Nichols, USASMDC

Room: I-271

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330-1500
Human-Centered Missile Defense System Development
Dr. Dan Tufano and Dr. C. W. Glover, Oak Ridge National Laboratory

A Model for Developing System Requirements for a Single Integrated Air Picture
Dr. J.F. Nicoll and Dr. J.F. Cartier, Institute for Defense Analyses

Plot Fusion Analysis Using the Extended Air Defense Testbed
Ms. Anna Schauer, POET/Sandia National Laboratories

Implications of High Performance Computing and Intelligent Technology for BM/C3
Dr. Robert F. Wells, POET/Los Alamos National Laboratory (POET/LANL)

Wednesday, 0830-1000
Air Defense Missile System vs. Cruise Missiles: Lethal Ground Effects Analysis
Mrs. Chris Susman, USAMSAA

A Methodology for Theater Ballistic Missile (TBM) Debris Shortfall Analysis for Directed Energy Intercepts
Mr. Manuel Perez and Mr. Keenan Kloeppel, Air Force Materiel Command

Weapons of Mass Destruction, Probability of Kill, and Firing Doctrine - Not Just the Same Old Thing
Mr. Paul E. Grim, SRS Technologies

US Army Air Defense Missile Inventory Allocation Against the Tactical Ballistic Missile Threat of the 21st Century
CPT Steve Millner, CPT Steve Vallejos, and Mr. Philip D. Whittle, US Army Air Defense Artillery School

Wednesday, 1030-1200
Joint Theater Air and Missile Defense
Captain Alan B. Hicks, USN, Theater Air Warfare Branch (N865E), Staff of the Chief of Naval Operations

"interPro" - Joint Theater Air and Missile Defense Interoperability Analysis
Mr. Philip Feld and Mr. Gary Hoehn, Schafer Corporation, and LTC James Tyson, JTAMDO

Information Management and Tactical Displays to Support the Area Air Defense Commander
Mr. Milton "Mickey" Gussow, The Johns Hopkins University Applied Physics Laboratory

US Navy Decision Aids To Support Area Air Defense Commander
Mr. Paul Willis, Whitney, Bradley, & Brown, Inc., and Mr. Simon Moskowitz and Mr. Daniel P. Syed, JHU-APL

Wednesday, 1330-1500
Wargame 2000 - A Real Time Human-in-the-Loop Simulator exercising the next generation CONOPS, Doctrine and TTP for National Missile Defense (NMD) and Joint Theater Air and Missile Defense (JTAMD)
LCDR Chris Arias, Joint National Test Facility and Mr Frank Deis, SPARTA

Use of Advanced Firing Strategies to Decrease Discrimination Requirements and Inventory in NMD Systems
Mr. Dwayne Pribik, Schafer Corporation and Mr. Lee Wilbur, Boeing

Defining the NMD C2 Operator Roles, Responsibilities, and Information Environment
Dr. Beverly G. Knapp, US Army Research Lab - Ft. Huachuca; Mr. Eric Barieau, System Technology Associates; and Mrs. Carol Daniel, Schafer Corp.

Verification and Validation of a Large Air & Missile Defense Simulation: Wargame 2000
Dr. Dale K. Pace, The Johns Hopkins University Applied Physics Laboratory

Thursday, 0830-1000
Planning Tool for Operational Fires (PTOF)
CPT Bill McLagan, US Army Concepts Analysis Agency

Analysis of Attack Operations
Mr. David McGarvey, RAND

JTMD AO JT&E Program Overview: Attack Operations Capability Test Results
Mr. Tom Neuberger, JTMD AO JTF, Center for Naval Analyses

Thursday, 1030-1200
MEADS Analysis of Alternatives
Mr. Mike Ellis, Quantum Research

Mathematical Analysis of Probabilities of Negation,
Dr. N.S. Sivakumaran and Ms. Laura Lee, SPARTA, Inc.

Obtaining Certified Theater Missile Defense Weapons System Data for Use in EADSIM - Lessons Learned
Mr. Jeffery Allen Randorf, USASMDC

Thursday, 1330-1500
JTAMD Experimentation-Based Assessments: " The Demo Plan"
LTC James D. Renbarger, JTAMDO, and Mr. Tom Pendergast, HJ Ford Associates

Advanced Concepts for Joint Theater Air and Missile Defense
Dr. Joan Cartier and Dr. Jeff Nicoll, IDA, and Mr. Jeff Rogers, Noesis, Inc.

ADASM - Air Defense Architecture Synthesis Model
Doug Brouse, and Paul McCoy, SAIC

Potential Benefits of External Cueing to Active TMD Systems
Mr. Jim Walsh, Coleman Research Corp.

WG 4 - AIR AND MISSILE DEFENSE – Abstracts
Room: I-271

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... Room I-122

Tuesday, 1330-1500
Human-Centered Missile Defense System Development
Dr. Dan Tufano and Dr. C. W. Glover
Oak Ridge National Laboratory
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The technologies associated with Theater Missile Defense (TMD) must integrate information into a usable form for both human consumption and automated processes. It is the interface with decision makers, human or computer, that tries to present to them a sufficiently clear, complete, unambiguous, accurate, correct, and timely compilation of information so that they may make an appropriate response to the existing situation. This paper addresses the needs of the human as the central element in the development of a total missile defense system. This paper examines recent work in human-systems research for time-critical decisions under stress and the impact it has on the Single Integrated Air Picture (SIAP) system design.

As called out in the Joint Theater Air and Missile Defense (JTAMD) Operational Concept, there are four main objectives that are necessary for effective execution of the TMD mission: 1) SIAP; 2) Early detection, classification, and identification; 3) Defense in depth; and

4) 360 degree coverage. The high degree of situation awareness provided by a SIAP is expected to enable sophisticated defense responses and battle management concepts to be successfully employed. For such situational information to be useful to the human decision maker, it must map onto the human's capabilities and needs in terms of: perception, cognition, and trust. This mapping takes place through the user interface with the system. The most important aspects of the interface here are the perceptual and logical. The perceptual part of the interface concerns the human's sensory and integrative processes. The spatial awareness required by the TMD mission covers geographical area, vertical slices of the air, and theater volumes. These needs are met by a variety of pictorial displays, supporting 2-D and 3-D presentations, which are easily selected and scaled by the user. The logical aspect of the interface concerns the balance between meeting the human's information needs and avoiding information overload. The crux of the logical interface is information access and management. The human must be able to call up a variety of information from one coherent interface, e.g.: track data and histories, actions taken or recommended, locations and operational envelopes of assets and potential threats, and evidence tables. Evidence tables should include information on the system's confidence in conclusions reached by the automated processes. Access to such information should help build trust and avoid a rapid deterioration of the user's confidence when conflicts do arise. The information management system must have the flexibility to let the human manipulate information that conforms to their mental models of the systems providing information and the situation they perceive to be developing. The general approach to developing the user interface is Human Centered System Design (HCSD). In this approach, the system is developed, from start to finish, from the point of view of the human user's: job, information requirements, and capabilities. HCSD must be considered at the start in the systems engineering process. It encompasses requirements definition, system concepts and design, and verification and validation. Before requirements are defined, however, HCSD begins with modeling of the user's job and capabilities, especially how these capabilities may change under varying levels of stress. It also includes, from the start, consideration of the requirements for the training system that will accompany the operational system. All development and testing must be conducted in concert with subject matter experts who are actual operators. Such an approach has been successfully used by the Navy (NCCOSC RDT&E Division [NRaD] and NAWC Training Systems Division) in their Tactical Decision Making Under Stress (TADMUS) program. This paper will examine lessons learned from TADMUS and the considerations needed for TMD HCSD.

A Model for Developing System Requirements for a Single Integrated Air Picture

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The Atlantic Command CINC is currently drafting a Capstone Requirements Document that would require a "single integrated air picture" or SIAP for all C2 nodes. To assist in reaching that goal, this report proposes a definition of SIAP. SIAP is defined in terms of measurable attributes of the tactical air picture. These measures can be used establish engineering specifications to meet operational requirements.

The authors have developed the J8 Architectural Assessment Tool (J8AAT) for characterizing the quality of the tactical air picture as a function of the platform and sensor laydown, communication architecture, and threat type. The model calculates a series of measures of performance which quantify how complete, clear, accurate and continuous the tactical air picture is at each command location in the network. The metrics are presented in a map format permitting a global appreciation of the state of the air picture across the theater.

J8AAT is used to evaluate current deficiencies of integrated air defense. Many of these can be traced to legacy hardware and on the various platforms, relatively long latencies, as well as integration inconsistencies across platforms. The most significant factors found to improve the air picture are (1) reducing gridlock and sensor registration errors, (2) the reduction of latencies and (3) common adaptive correlation and decorrelation algorithms for all contributing platforms. The introduction of measurement fusion on key platforms can be the final step in establishing a SIAP.

Plot Fusion Analysis Using the Extended Air Defense Testbed

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The Ballistic Missile Defense Organization has conducted a study to analyze all aspects of a Joint Composite Tracking Network (JCTN). In a JCT Network, sensors (typically radars) and their respective processors are linked via a communications network. As targets are detected by any sensor in the network, the low-level plot data is distributed to all processors in the network. Each processor treats the data as if it had been generated by its sensor. Within this framework, it is possible to launch weapons which are outside the field of view of the local sensor.

A study of this magnitude identifies many issues and tradeoffs. Some analysis and simulation tools exist to explore specific aspects of the proposed design. In parallel with the JCTN Study, the Ballistic Missile Defense Organization conducted a study with the Extended Air Defense Testbed. A proof-of-principle (PoP) plot fusion capability has been added to the EADTB, and results compared to other, more limited analysis tools. This paper describes the results of the PoP Plot Fusion study, and discusses future analyses which may be conducted with further modifications to the EADTB software.

Implications of High Performance Computing and Intelligent Technology for BM/C3

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This presentation reflects the author's experience working with a Washington-base consortium of premier RD&A organizations (including the Institute for Defense Analyses, RAND, MITRE, MIT's Lincoln Laboratory, Johns Hopkins University's Applied Physics Laboratory, Logistics Management Institute, Aerospace Corporation, and the Department of Energy's Lawrence Livermore, Los Alamos, Oak Ridge, and Sandia national laboratories) supporting the DoD's Ballistic Missile Defense Organization (BMDO). The author is involved in two state-of-art simulation programs that use, or plan to use, High Performance Computing (HPC) technologies: an object-oriented joint forces missile defense wargame development and a hydrocode-based lethality assessment capability for study of hyper-velocity missile defense endgames. The two HPC applications represent two ends of a spectrum: the hydrocodes deal with first principle physics-level behavior of interacting missiles, while the wargame addresses the global context of large scale warfare, which must emphasize human behavior. The presentation focuses on the implications of HPC for development of suitably intelligent components for modeling Battle Management/Command, Control, and Communications (BM/C3). The author draws upon the HPC progress being made via the Department of Energy's Accelerated Strategic Computing Initiative (ASCI), which is being carried out by Los Alamos, Lawrence Livermore, and Sandia national laboratories, who are teamed, respectively, with Cray Research/Silicon Graphics, IBM, and Intel. Global modeling and simulation, whether military or non-military, needs to employ intelligent techniques in two contexts. First, the enormous influence of human decision making, at both macro and micro levels, must be appropriately represented within the model structure. Second, intelligent techniques are needed to facilitate the modeling and simulation processes themselves (e.g., knowing how to select suitable representations of entities and processes from a continuum ranging from the highly abstract to the finely detailed, while balancing other needs, such as simulation runtime, data availability, data confidence, memory management, analytical integrity, and representational consistency). ASCI has already achieved its initial supercomputing goal of one trillion computations per second (Teraops) and is working towards a 100-Teraops capability by the year 2004. ASCI's goal is in the range we attribute to the human brain's processing capability. While the growth of computational power, described by Moore's Law as doubling roughly every 18 months, is well known, people have a tendency to project the future "linearly". In fact, numerous technologies are advancing exponentially, leading to unprecedented, but virtually certain, advances in intelligent technologies. During the coming decade we can anticipate a rapidly expanding ability to incorporate needed intelligence in complex modeling and simulation systems that will enhance the use of simulation for a wide range of BM/C3 investigations.

Wednesday, 0830-1000:

Air Defense Missile System vs. Cruise Missiles: Lethal Ground Effects Analysis

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This paper describes the methodology used to quantify the lethal effects that potentially could result from an Air Defense missile intercepting a Cruise Missile carrying a payload of mass destruction. The payloads examined include chemical, biological and nuclear warheads. The resulting location on the ground, area of coverage, and lethal level for each payload, due to the intercept, were calculated. A corresponding keep-out range, for each payload, was derived from these calculations. The keep-out range is defined as the intercept range that must be maintained to minimize the lethal effects that could occur on the Air Defense fire unit when operating in a self-defense mode. The results can also be used to examine keep-out ranges for individual defended assets and the capability of the Air Defense System to maintain those ranges. This information would allow a variety of Air Defense laydowns to be examined and any potential shortcomings in a defense deployment, that may exist, to be identified.

Debris Shortfall Resulting from Bost Phase Intercept (BPI) of Theater Ballistic Missiles (TBM)

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Boost Phase Intercept (BPI) systems destroy theater missiles prior to booster burnout. To date there has been little understanding of the debris patterns resulting from BPI. In this paper, the Office of Aerospace Studies (OAS) reports on tool development and subsequent analyses investigating these patterns for various TBM types.

Weapons of Mass Destruction, Probability of Kill, and Firing Doctrine - Not Just the Same Old Thing

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Current typical firing doctrine for U.S. PATRIOT units is to fire two missiles at each incoming TBM. Does this provide an adequate defense against incoming TBMs for various types of assets that a CINC may wish to protect? This paper looks at analysis of the possible effects of various types of TBM warheads on airbases and ports and the effects of 'leakers' on those assets. After discussing the effects of chemical and conventional TBMs on these assets, the paper looks at the probability of preventing leakers against various sized TBM attacks given the current typical firing doctrine, recommends possible changes to the firing doctrine under some conditions, and discusses the impact of those firing doctrine changes on a theater and its overall TMD defense design.

While the impact of conventional HE TBMs on an airbase will probably not have a major effect, various studies have indicated that the impact of one or more chemical TBMs can have a major effect on the sortie rate of airbases; possibly having a great affect on the CINCs campaign. Additionally, even a leaking HE TBM can close a port if it impacts on off-loading ammunition sites. The conclusion from this is that under various conditions – especially WMD for airbases and all TBMs for ports – it is imperative that our active defense forces do not allow any leakers. Using the Single Shot Engagement Probability of Kill, we can see that today's firing doctrine cannot adequately defend against massed TBM attacks. In order to adequately prevent leakers it is necessary to fire more interceptors at each incoming TBM than today's typical firing doctrine dictates. This has various affects on the number of assets our forces can adequately defend and the missile inventory required to accomplish this defense.

US Army Air Defense Missile Inventory Allocation Against the Tactical Ballistic Missile Threat of the 21st Century

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The US Army Air Defense Artillery missile inventory is a stockpile of heterogeneous missiles with varying degrees of accuracy and probabilities of kill against various threat target types. These missiles, especially those of the Patriot system, rest in inventory as either certified or re-certified last production rounds, or as certified or re-certified upgraded and/or continued production rounds. The threat is expected to expand in the 21st Century with virtually every nation having a tactical ballistic missile capability. The inventory question, and the focus of this study, becomes one of how best to utilize these missiles to meet the emerging threat.

The potential for inefficiency, due to varying missile range constraints and probability of kill versus the threat target types, results in undesirable missile wastage. The study approach is to address this as a missile-threat allocation problem with the objective of maximizing the effectiveness of the family of air defense artillery weapons in destroying threat targets while minimizing the ammunition requirements and thereby cost. The analysis will show the multi-tiered contributions to Active Defense and to the overall value of the battle by evaluating the upper tier THAAD and lower tier PATRIOT weapon system elements.

Wednesday, 1030-1200:

Joint Theater Air and Missile Defense

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Conducting air defense on tomorrow's battlefield will require joint operations by air defense forces from multiple services that are integrated to a degree not previously achieved. The increasing range, speed and quality of the threat, coupled with the improved range and capability of air defense weaponry make current doctrine with its establishment of traditional separate Missile Engagement Zones (MEZ) and Fighter Engagement Zones (FEZ) inefficient and ineffective.

In the great majority of likely areas of operation in 2010, the battle space will include the sea-land interface in the littoral where Army, Navy, Marine and Air Force systems will overlap in coverage and capability. On one hand, the complexity of employing our advanced multi-service systems in this compressed battle space against an increasingly sophisticated threat presents significant challenge from a coordination standpoint. On the other hand, new technology provides an opportunity to develop, test and employ new doctrine, tactics, techniques and procedures which will result in an explosive increase in combat capability by ensuring true unity of effort from our new and complementary joint air defense systems.

The aircraft, sensors, weapons and command and control systems for this new 2010 force are all in development. To achieve the full combined capability of our new air defense systems, the Area Air Defense Commander (AADC) must be given the authority necessary to accomplish the TAMD mission which requires that he be empowered to plan operations and direct tactical operations of our emerging broad mix of air and missile defense forces at sea, ashore and in the air.

"InterPro" - Joint Theater Air and Missile Defense Interoperability Analysis

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The Joint Theater Air and Missile Defense Organization (JTAMDO) is responsible for planning, coordination, and oversight of joint integrated Theater Air and Missile Defense (TAMD) operational requirements and serves as the focal point for combatant command, Service, and Joint Staff Warfighter collaboration for requirements generation and joint operational concepts. JTAMDO has published a fully integrated TAMD BMC4I Joint Architecture, an overarching vision and structure that serves as the basis for making architecture recommendations to improve TAMD BMC4I interoperability.

Supporting the architecture development activities, Schafer Corporation has developed for JTAMDO a web-based joint TAMD interoperability analysis tool - interPRO - which permits Warfighters/analysts to address the detailed facts that comprise the joint TAMD BMC4I Operational, Systems, and Technical Architectures through the use of an advanced, user-friendly human-computer interface; interPRO addresses information exchange requirements (IER) for inter-system (and inter-Service) compatibility and interoperability, and supports Warfighter force deployment planning. InterPRO, which also incorporates Joint Interoperability Test Center (JITC) interoperability assessment data, supports a wide range of analyses:

* Assessing communications connectivity between existing or notional TAMD systems.

* Associating activities (from the TAMD Operational Architecture) with existing TAMD Systems and identifying which IERs can and cannot be supported and the cause of the deficiency, and for those that cannot be supported, the activities affected.

* Assigning activities to a notional TAMD System and identifying which IERs can and cannot be supported, and for those that cannot be supported, the activities affected.

* Determining connectivity between existing and/or notional TAMD Systems, identifying where compatibility/interoperability does or does not exist, the cause of any deficiency and the affected IERs and activities.

This paper presents an overview of interPRO, demonstrates its analysis capabilities and illustrates how web-based technologies are being applied to support DoD analyses.

Information Management and Tactical Displays to Support the Area Air Defense Commander

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The NDIA's (National Defense Industrial Association) Strike, Land Attack and Air Defense (SLAAD) Committee was tasked by the Director, Theater Air Warfare (N865) in July 1996 to undertake an industry and Navy cooperative study on information management and tactical displays to support the AADC. The effort was endorsed by the Director of Navy Surface Warfare (N86). The final report is due for presentation and distribution during the spring of 1998. Thus it is timely to present the results of this study to MORS.

The general approach follows five steps: (1) define the AADC role, (2) identify what is currently available to do it with, (3) assess how well the job can be done with what is available, (4) identify areas of improvement, and (5) provide a technology roadmap on how an improved AADC capability can be achieved c 2010. Under that fabric, the AADC functions in the planning and execution phase were delineated; an information source matrix vs each phase was generated; an information system architecture construct for an Aegis cruiser was proposed, and a display matrix for each AADC function to a display mode was mapped. Additionally, a methodology to identify the most promising emerging technologies was offered, with the top technologies illustrated by a quad chart each showing a picture or schematic of a specific technology, current system performance shortfalls, desired system capability, and a description of that technology. For example, two key technologies in the tactical display area are thin color plasma display panels and 3-D visualization.. The report concludes with a list of AADC conclusions and recommendations.

US Navy Decision Aids To Support Area Air Defense Commander

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The advent of technologically advanced threats, such as ballistic and cruise missiles, and the availability of these capabilities to an increasing number of potential adversaries have dramatically complicated the mission of theater air defense (TAD). These new threats pose new and unique problems, including limited response times and difficulties in detection, resulting from decreased radar cross sections, reduced infrared signatures, and techniques for avoiding detection such as the use of terrain. The solution lies partially in increased coordination among sensors, fusion/netting of sensor data, and coordination of engagements. The solution must also include the development of decision aids and planning tools that enable the Area Air Defense Commander (AADC) to provide the most effective and efficient air defense capability possible.

The Navy's AEGIS fleet provides a unique and powerful capability, but its full potential cannot be exploited if its assets are used ineffectively. Future AADCs will need to balance the need for additional coverage and detection range with radar resource availability, the nonoverlapping stationing requirements of area and theater-wide systems; and the competing demands of defense against tactical ballistic missiles (TBMs) and conventional Anti-Air Warfare (AAW) threats. Automated, yet interactive, planning aids will be a vital tool in the decision-making process.

Our paper describes the kinds of planning tools and decision aids required to generate sophisticated Air Defense Plan(s) to simultaneously counter ballistic and cruise missiles. It also describes the capabilities required to enable the AADC to influence execution in a dynamic combat environment.

Wednesday, 1330-1500

Wargame 2000 - A Real Time Human-in-the-Loop Simulator exercising the next generation CONOPS, Doctrine and TTP for National Missile Defense (NMD) and Joint Theater Air and Missile Defense (JTAMD)

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The Ballistic Missile Defense Organization (BMDO) together with the Joint National Test Facility is developing the next generation Command and Control Simulator called Wargame 2000 to support BMDO and warfighter requirements to evaluate CONOPS, Doctrine and TTP for NMD and JTAMD systems. Wargame 2000 fills an important role between the traditional analytic simulators used in architecture and system performance studies and the training simulators used to train operators on "today's" hardware capabilities. Wargame 2000 is an acquisition support tool with the flexibility to model the "what ifs" associated with evolving design and development alternatives and assess their impact on human operability and, in turn, the humans impact on the system performance. The goal is to provide human usability feedback in the form of CONOPS, Doctrine and TT&P evaluations to the acquisition team as the design evolves. This paper presents the Wargame 2000 operational concept and architecture from the perspective of the unique capabilities and features it must have to accomplish its acquisition support mission.

Command and Control Simulations (C2 Simulation) are a powerful tool for addressing the Human-in-Control (HIC) issues related to NMD and JTAMD systems effectiveness. Wargame 2000's primary mission is to examine, develop and model missile defense system CONOPS, doctrine and tactics, techniques and procedures through the use of highly realistic human in control experiments conducted in a simulated combat environment that includes the real world confusion caused by the fog of war. The objective is to investigate HIC processes and defense system features that, working together, help the operators perceive and interpret the battlefield situation, diagnose the current problem, select and implement the appropriate actions and then monitor the results of those actions and correct them as necessary. A key aspect of Wargame 2000 is its recognition that Command and Control decisions are based upon information that is inherently uncertain and that the contributors to this uncertainty must be included in the simulator if the findings are to be indicative of real world performance. These considerations have driven Wargame 2000 to adopt an advanced, parallel discrete event simulation framework that will ultimately support a higher level of detail in missile defense modeling than was previously possible in C2 Simulation. The increased processing capacity, higher level of detail modeling and more realistic displays make it possible to study HIC interaction responses, human decision making and time lines in terms of appropriateness, mission impact, operator workloads and effectiveness of the decision support tools.

Through the use of C2 Simulation techniques CONOPS, doctrine, tactics, techniques and procedures, and decision support systems can be studied in a broad battlefield context (including "fog of war" uncertainties) with the goal of developing a human usable combination that maximizes the defense system's effectiveness as an integral part of the acquisition process.

Use of Advanced Firing Strategies to Decrease Discrimination Requirements and Inventory in NMD Systems

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Inclusion of advanced penetration aid (penaids) suites in ICBMs greatly increases the requirements on ground based radars (GBR) to discriminate objects in NMD Systems. Advanced penaid devices such as chaff, jammers, erectable decoys and IR balloons, can require increases in GBR beamwidth, power and discrimination algorithm capability. The potential exists to use advanced firing strategies such as Shoot-Look-Shoot, Shoot-Evaluate-Divert, and Shoot-Replace-Evaluate-Divert to decrease not only the need for high accuracy discrimination but to relax requirements on Single Shot Probability of Kill (SSPk), while still meeting mission objectives with reduced inventory. The authors present results of trade studies performed using binomial analysis and Monte Carlo simulation of firing strategies, over a trade space of Probability of Discrimination and SSPk. The results indicate that GBR discrimination can be reduced to give only a rudimentary object count and perform kill assessment, and that NMD SSPk becomes secondary to enlarged battlespace in threats with advanced penaids.

Defining the NMD C2 Operator Roles, Responsibilities, and Information Environment

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This effort is part of an ongoing analysis activity initiated by the National Missile Defense Joint Project Office Battle Management/Command, Control, and Communications (NMD-JPO BM/C3) office to define and model new C2 operator roles, responsibilities and information needs for a system with no immediate predecessors. Consensus in the NMD operational community is that NMD C2 functions will be shaped using existing missile warning, space surveillance and ground air defense systems as a point of departure. However, system developers for NMD BM/C3 suggest that this new system will be a highly sophisticated, largely automated defensive capability that will revolutionize traditional human operator roles. Knowledge elicitation focus groups leading to the development of a constructive NMD C2 simulation was the analysis approach used to address these concerns.

First, two focus groups were held where candidate operator functions, task flows and information requirements were elicited from NMD subject matter experts, using cognitive task analysis scaling methods, including unconstrained card sorting, and consensus building exercises to establish a baseline. Next, a decision tree analysis was conducted to begin clustering task groups with information items. Data from these group sessions were then used to begin construction of a computer-based simulation to examine tradeoffs. A first generation simulation using the MicroSaint human performance modeling tool has been developed and is currently under initial review.

Verification and Validation of a Large Air & Missile Defense Simulation: Wargame 2000

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Wargame 2000, being developed by the Ballistic Missile Defense Organization (BMDO) at the Joint National Test Facility (JNTF), is intended to support warfighters in examining their CONOPs, doctrine, tactics, techniques, procedures, and plans for specified air and missile defense command and control infrastructures. Wargame is expected to have five modes (or kinds of application): 1) concept of operations (CONOPS) development (expected to be the most commonly used mode or application), 2) CINC assessment and field exercise, 3) staff and operator familiarization, 4) architecture assessment, and 5) test and evaluation (T&E) support. Wargame 2000 will be the replacement for ARGUS (Advanced Real-Time Gaming Universal Simulation), which has provided useful ballistic missile defense war gaming capability over the past decade. Verification and validation (V&V) of Wargame 2000 is a daunting task. This presentation will describe BMDO's V&V approach and will discuss issues related to V&V of a large human in control (HIC) air and missile defense command and control (C2) simulation.

Thursday, 0830-1000

Planning Tool for Operational Fires (PTOF)

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The Planning Tool for Operational Fires (PTOF) is a powerful yet simple dynamic model and methodology that was literally developed overnight by analysts at the US Army Concepts Analysis Agency (USACAA). This model and methodology were developed as a planning tool to model operational fires to support course of action analysis for the US Army Central Command (ARCENT) G3 Plans staff during exercise Roving Sands '97 held at Fort Bliss, Texas from 20-26 April 1997. This model was developed to assess the current effects of operational fires for the courses of action developed for the Roving Sands exercise. This model is a valuable planning tool available to the commander, which is capable of estimating the future effects of planned fires for different courses of action over time. This model also allows the commander the ability to perform rapid trade-off analysis to predict the effects of changes and modifications to operational fires for alternative courses of action, branches and sequels. Operational fires consist of those assets used to execute joint attack operational and deep fires in support of the deep battle. This model synchronizes these operational fires with operational maneuver. During Exercise Roving Sands, the Commander ARCENT and the CinC, US Central Command (USCENTCOM) directed that the PTOF model and methodology be used in future analysis to assess ARCENT and USCENTCOM OPLANs.

Analysis of Attack Operations

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This paper describes a model for evaluating the effectiveness of those attack operations (AO) concepts in which committed assets attempt to find and attack tactical ballistic missiles (TBMs) and their transporter/ erector/launchers (TELs) during the periods immediately before and after attempted TBM launches. The model uses a connected sequence of Markov chains to calculate the probabilities of key states of the AO system and is called the Markov Attack Operations (MAO) model. Other approaches to the analysis of selected aspects of AO which are analytically simpler and more transparent or which more faithfully model certain aspects of AO are also treated.

The paper illustrates the use of the these techniques to analyze the sensitivity of performance to such factors as: area that must be searched; sensor and target recognition performance parameters; use of uncued or cued search; false targets and false cues; timelines of weapons, sensors and enemy operations; enemy activity rates; and the impact of constraints on platforms, weapons, and cue processing rate.

The analysis of cued search with processing rate constraints provides an interesting example of the interplay of search theory and queuing theory. This relationship is developed in the paper.

JTMD AO JT&E Program Overview: Attack Operations Capability Test Results

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The Joint Theater Missile Defense Attack Operations (JTMD AO) Joint Test Force was chartered by OSD to investigate CINCs' capabilities to conduct attack operations in several theaters of operation with varying force structures. The JTF is focused on four critical operational issues:

* Do near-term sensors adequately support JTMD AO?
* Does near-term C4I effectively contribute to JTMD AO?
* Do near-term attack systems effectively execute JTMD AO?
* What net impact does the conduct of JTMD AO have on systems which have multiple mission support requirements?

This paper provides an overview of the JTF's program and summarizes results from the first three test phases which included field testing and the application of a large-scale man-in-the-loop distributed simulation architecture called the Attack Operations Simulation Network (AOSN). Major topics include real-world command and control architectures and their impact on AO timelines, attack system capabilities, and intelligence, surveillance, and reconnaissance (ISR) issues. The paper concludes with a summary of current Phase IV efforts and plans for future attack operations study.

Thursday, 1030-1200:

MEADS Analysis of Alternatives

Mr. Mike Ellis, Quantum Research ***Abstract unavailable at printing.***

Mathematical Analysis of Probabilities of Negation,

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The Theater Missile Defense (TMD) Capstone Requirements Document (CRD) gives definitions for the *per target* probability of negation (*Pn*) and also for the Family of Systems (*FoS*). In order to evaluate the baseline TMD architecture against the requirements posed in the CRD, it is necessary to define *Pn* in terms of its component probabilities in the Sensor, the BM/C4I and the Weapon systems forming the specific *FoS*. The concept of *Pn*, which is based upon an individual missile trajectory as described in the CRD, is extended to derive two additional methods of assessment for negation by an *FoS*: (1) The contour map of minimum *Pn* covering the defended area; (2) The *probability of negation for the entire scenario*, which is a single number defining the probability of negating a single missile launched from a random threat location at a random critical asset location in the entire scenario (i.e., negating any one random missile in the entire scenario). These methodologies are applied to various theaters of interest to demonstrate their usefulness to the warfighter in order to evaluate particular TMD architectures (year 2003 and 2010) and defense laydowns.

Obtaining Certified Theater Missile Defense Weapons System Data for Use in EADSIM - Lessons Learned

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The U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) is conducting an Analysis of Alternatives (AoA) for the Medium-range Extended Air Defense Weapon System (MEADS) using the Extended Air Defense Simulation (EADSIM) as one of the analytical tools. This paper describes the procedure used to obtain system performance data on the weapons, sensors, and threats modeled in the EADSIM scenarios. Over thirty weapon and sensor systems were modeled in EADSIM, to include MEADS, the Theater High Altitude Area Defense System (THAAD), Patriot, Hawk, the Airborne Warning and Control Systems (AWACS), the Short Range Air Defense System (SHORADS), Navy Theater Wide (NTW), Navy Area Defense (NAD), and various Air Force and Navy fighter aircraft and air-to-air weapons. The paper provides details on the procedure and timelines for obtaining data. Details on the data entry, verification, and dependency checking within EADSIM are discussed. Examples of this are the relocation of red and/or blue systems within the scenario and the effects of "design-for-scenario" data. Problems with over-modeling within the EADSIM scenario and its impact on the data collection process are described. Finally, a proposal for post-study data maintenance and management is presented. A complete point-of-contact list is provided in the appendix.

Thursday, 1330-1500

JTAMD Experimentation-Based Assessments: "The Demo Plan"

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In April 1997, the Theater Air and Missile Defense (TAMD) Executive Committee (EXCOM), co-chaired by General Ralston and Dr. Kaminski, met to review TAMD Master Plan progress. The EXCOM determined that there should be positive steps taken to maintain progress toward a Joint TAMD (JTAMD) demonstration in the 2002/2003 time frame to validate integrated system performance in a tactically stressing environment and ensure a residual deployable capability. Subsequently, a collaborative effort between JTAMDO and BMDO was formed, known as the JTAMD Experimentation-Based Assessments Plan or the Demo Plan, to carry out this mission. This presentation will provide the details of the plan and discuss the role of modeling and simulation in the plan's assessments process.

Advanced Concepts for Joint Theater Air and Missile Defense

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The Joint Land Attack Cruise Missile Defense (JLACMD) Study was led by the Joint Staff. The study focused on US capabilities circa 2002 and 2005 to counter the emerging cruise missile threat. A long-term goal of the study was the establishment of an objective operational architecture to facilitate the integration efforts among Service acquisition communities. This joint architecture would have to satisfy the unique requirements of each service, but also improve the interfaces between systems, enable new operational concepts, or significantly improve existing concepts in order to meet the evolving threat.

Advanced concepts were constructed to show technological improvements to 1) Airborne Surveillance, 2) Airborne Fire Control, 3) Advanced Fighters, and 4) Air-Directed Surface-to-Air Missiles (ADSAM). Given various combinations of advanced concepts, the architectures were evaluated by

their ability to provide Critical Asset, Limited Area, or Theater-Wide defenses. A principle finding of the study was that current and advanced operational concepts share a requirement for a single integrated air picture (SIAP).

Two parallel approaches were utilized to evaluating current and future architectures. Standard force-on-force modeling (EADSIM) was used to estimate leakers and depth of penetration. A new model (J8 Architectural Assessment Tool (J8AAT) was developed to model the affect of advanced systems and networks on the quality of the air picture - as well as engagements.

ADASM - Air Defense Architecture Synthesis Model

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ADASM is an architecture-level optimization model which solves for the most cost effective mix of theater air and missile defense assets to meet the requirements of theater conflicts. ADASM's linear programming formulation reflects the inherent trade-offs between the capabilities and associated costs of the defense assets, the threat characteristics, and the desired defense effectiveness goals and requirements. The ADASM formulation decomposes threat and defense asset interactions through a grid of space (corridors and distance bands) and time. Each target engagement must meet the kill chain requirements associated with surveillance, fire control, and weapon. The chief objective function metric is the life cycle cost associated with providing the defense architecture necessary to satisfy requirements.

The threat scenario is described by the raid size, speed, altitude, routes, attack timing, signature, and terrain. The defense systems are described by sensor capabilities, weapon capabilities, range, capacity, endurance, probability of kill, BMC4I timelines, and engagement rules. Architecture costs are based on life cycle costs for each platform, including acquisition and O&S. Defense effectiveness requirements may be specified as leakage, keepout distance, and budget limits. ADASM outputs include the optimal defense force mix, Pareto region performance, sensor and weapon allocations per target, resulting threat keepout distance, and requirements satisfaction. ADASM can be solved as either a linear program or an integer program. The model is designed to support a variety of analyses including architecture design, preferred force mixes, requirements impacts, BMC4I alternatives, and TMD, CMD, attack ops, and BPI trade-offs. The typical ADASM problem size is 15,000 constraints and 12,000 variables. ADASM uses the MINOS solver which provides for run times on a SUN Sparc 20 or Pentium in 5 to 30 minutes. The design and development of ADASM has been sponsored by JTAMDO.

Potential Benefits of External Cueing to Active TMD Systems

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The potential for space-based or airborne sensors to cue theater missile defense fire control radars such as the Army's THAAD radar and the Navy's SPY-1 has been given considerable attention in the TMD community over the past several years. Numerous studies and symposia have focused on various aspects of the external cueing issue. This paper provides a summary of cueing studies undertaken and supported by the Army PEO AMD.

The objective of these study efforts was to define the conditions under which external cueing is beneficial to Active Defense TMD systems. The conditions that are addressed include: the fire control functions that can be enhanced by external cueing; the requirements on the external sensor in order to provide a benefit; and the key threat parameters that influence if and when external cueing provides value to the active defense systems.

The results of external cueing studies have demonstrated that given the proper conditions, external cueing can be of value to active defense TMD systems. The results also show that the proper conditions are circumscribed and specific to each TMD system and are tied to specific threat classes and operational situations. Results further indicate that the requirements on the external sensor are demanding and that to fully exploit the potential benefits of cueing will entail new requirements on the active defense systems. Active defense requirements to exploit external cues include software for processing the information but more significantly may require new hardware such as interceptor communication systems to support advanced engagement operational concepts such as remote engagements.

One of the major lessons learned from this set of studies is the importance of a detailed understanding of the operations of the active defense system that is to be supported by external sensors. Without such an understanding, to include resource utilization, self-cueing techniques, effective missile battlespace, radar sector limitations, and others the proper conditions for external cueing can not be determined.

WG 4 - AIR AND MISSILE DEFENSE - Alternate

Evaluation Of System Performance Using Supplementary Data

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During the various phases of system development it is important to maintain an estimate of whether the system will meet its performance requirements when it becomes "operational". Estimates of operational performance during development phases indicate whether the development is "on track" and are important criteria to be considered for advancing the program. In the development phase we obviously do not have a "population" of *operational* (i.e., production) items from which to sample. We must rely on development items for indications of how the operational item will perform. Furthermore, as systems become more complex, and expensive, the amount of total system testing decreases. Consequently, means other than just full system tests are needed to provide evidence on the performance of the system.

Potential sources of information, other than full system tests, include subsystems and component tests and are denoted as "supplementary data". In order to use supplementary data to address the question of performance of the operational system, it is often necessary to invoke engineering judgment. We are developing a process that will quantify the effects of judgmental factors on the degree of belief in an estimate of whether a system will meet its requirements. An explicit evaluation of the degree of belief in meeting requirements, which includes effects of judgmental factors, has many advantages. This paper presents a description of the process, which has been named the "Expanded Confidence Assessment Process" (ExCAP), and its application to missile defense system evaluation.

WG 5 – OPERATIONAL CONTRIBUTION OF SPACE - Agenda
Chair: Maj Dan Zalewski, AFSAA
Room: G-129

Tuesday, 1030-1200:
Designing a Long-Term Space Systems Architechture through Optimizaion
1Lt Giddings, Capt Wiley, Mr Lewis, Maj Gooley

Technology and Applications of a Space Operations Vehicle System
Col Craig R. McPherson, Director, Space Operations Vehicle Program AFRL/VSD

Ground vs Air launched Considerations for Military Spaceplanes
Capt Maharrey, Mr Snead, Mr Feuchter, Capt Platt

Tuesday, 1330-1500:
COMPOSITE GROUP A SESSION .... Room G-109

Wednesday, 830-1000:
Joint Session WG 5, 6, & 11 .... Room G-102

Wednesday, 1030-1200:
Joint Session WG 5 & 11 .... Room G-102

Thursday, 830-1000:
Evaluating Alternatives for GPS Modernization: A User Perspective
Capt Lucia, Maj Lehmkuhl, Col Feldman

Grenadier BRAT Warfighting Rapid Acquisition Program Requirements Analysis
Mr Smock, MAJ Harwig

The Use of Operational Modeling and Simulation in Test, Evaluation and Wargaming: GPS on the Battlefield
Mr Friedman, 2LT David Ozmen

Thursday, 1030-1200:
Military Worth of GPS
Mr Tabler, Maj Zalewski

Employment of JDAM in a GPS Jamming Environment
Mr Jeff Sackett

Thursday, 1330-1500:
Intelligence, Surveillance, Reconnaissance, and Strike (ISR) Investment Study
Maj Jim Barnes, Mr Kurt Willstatter

Abstracts for WG-5 unavailable at printing.

WG 6 – C4ISR – Agenda

Chair: LTC Patrick Vye, JCS, J6, Technology and Architecture Division
Cochair: Mr. Chris Chartier, Joint C4ISR Decision Support Center
Cochair: Mr. Jon Grossman, RAND

6A: Room – G-303; 6B: Room – G-306; 6C: Room – G-386

Tuesday, 1030 - 1200
Working Group Session 1A.. Room G-303
Methods for Information Valuation
Professor Alan Washburn, U.S. Naval Postgraduate School

On Linking C4ISR Improvements to Increases in Military Effectiveness
Charles Hall III, The Mitre Corporation

Contribution of C4ISR Systems to Joint Close Support
Patrick G. Smock, TRADOC Analysis Center

Tuesday, 1030 - 1200
Working Group Session 1B.. Room G-306
Reengineering the Wheel: Integrating System and Process Development
Kenneth E. Kaizer, Booz-Allen & Hamilton

Evaluating Alternative Systems Architecture
Dr. Louis Moore and Dr. Walter Perry, RAND

Modeling Alternative C4ISR Architectures
CPT(P) Ross Snair, Tim Bailey; TRADOC Analysis Center

Tuesday, 1330 - 1500
COMPOSITE GROUP B SESSION.. Room G-109

Wednesday, 0830 - 1000
Joint Session with WG5 & 11.. Room G-102

Naval Oceanographic Applications of Space Systems
Mr. James Rigney, Naval Oceanographic Office

An Overview of Orbital Imaging Corporation's Satellite Imaging Services
Mr. Joe Dodd, Orbimage, Inc.

EARTHWATCH
Mr. Jeffrey Kerridge, EARTHWATCH

Commercial Remote Sensing Can Change the Environment of Military Forces
Dr. Tish Williams, Space Imaging EOSAT

Wednesday, 1030 - 1200
Working Group Session 4A.. Room G-303

The Necessity for Integrating Space Assets into Campaign Analysis
Capt James R. Hunter and Capt Mark A. Powers, USAF, SMC/XR

Measuring Dominant Battlespace Awareness to Support Force Mix Analysis of Imagery Systems
Art Dougas, Booz-Allen & Hamilton

Overview of Joint C4ISR Decision Support Center FY98 Studies
Charles Taylor, Joint C4ISR Decision Support Center

Wednesday, 1030 - 1200

Working Group Session 4B.. Room G-306

Entropy Based Warfare: The Mathematics for a Unified Theory of Modeling the Revolution in Military Affairs
Mark Herman, Bill Thoet, Christopher Ling, and Dr. Edward Splitt, Booz-Allen & Hamilton

Modeling With a Lack of Intelligence
Capt Victor Wiley, USAF, Office of Aerospace Studies (AFMC)

The Use of Fuzzy Logic in Composite Threat Assessment
Anthony Cowden, Sonalysts, Inc.

Wednesday, 1330 - 1500

Working Group Session 5A.. Room G-303

Measuring Dominant Battlespace Awareness to Support Force Mix Analysis of SIGINT Systems
Bill Thoet, Booz-Allen & Hamilton; and Bill Ryder, NSA/P5

Analyzing the Military Worth of SIGINT Geolocation Accuracy
Lt Michael Rosenbaum, ESC/DIS; Michael E. Wright, System Simulation Solutions, Inc.; and Steve Topper, Teledyne Brown Engineering

Inter-Sensor Registration Requirements
W. C. J. Hunter, A. J. Perrella, J. F. Nicoll, and J. F. Cartier, Institute for Defense Analysis

Wednesday, 1330 - 1500

Working Group Session 5B.. Room G-306

Unmanned Aerial Vehicles (UAVs) as Communications Platforms
Virginia Wiggins, Joint C4ISR Decision Support Center

NETWARS Communication Burden Analysis of a Small Joint Task Force
LTC Patrick Vye, USA, Joint Chiefs of Staff, J6, Technology and Architecture Division

Communications in JWARS and NETWARS
Dr. Allen S. Rehm, The Mitre Corporation

Thursday, 0830 - 1000

Working Group Session 6A.. Room G-303

The Sensor-to-Shooter (Battle Management) Study
LTC Patrick Vye, USA, Joint Chiefs of Staff, J6, Technology and Architecture Division

Optimizing Assignment of Air-to-Ground Assets and BDA
LtCol Kirk Yost, USAF, U.S. Naval Postgraduate School

US/UK Sensor-to-Shooter Coalition C4 Interoperability Study
LtCol Stephen Lisi, USAF, Joint Chiefs of Staff, J6, Technology and Architecture Division

Thursday, 0830 - 1000

Working Group Session 6B.. Room G-306

C4ISR Impacts on Strike Warfare
Charles Taylor, Joint C4ISR Decision Support Center

Modeling Approach for Joint C4ISR Decision Support Center Study "C4ISR Impacts on Strike Warfare"
Kevin Murray, Booz-Allen & Hamilton

An Application of the Dynamic C4ISR Analytic Performance (CAPE) Model to C4ISR Effectiveness
Jeremy Baldina, Henry Neimeier, Karen Pullen, and Dr. Richard Tepel; The Mitre Corporation

Thursday, 1030 - 1200

Working Group Session 7A.. Room G-303

A Methodology for Assessing Programmatic Viability of Joint C4ISR Systems
Dr. Peter S. Liou, Institute for Defense Analysis; Michael Moran, Joint C4ISR Battle Center

Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP)
Patrick G. Smock, and MAJ John M. Harwig, USA; TRADOC Analysis Center

Cause-and-Effect Experiments in Warfare Modeling and Simulation: C4ISR Impacts
C. Christopher Reed, Robert H. Weber, Dorian Buitrago, and David Goldstein; The Aerospace Corp.

Thursday, 1030 - 1200

Working Group Session 7B.. Room G-306

InterPRO – Joint Theater Air and Missile Defense Interoperability Analysis
Phillip Feld, Schafer Corp.; Gary Hoehn, Schafer Corp.; and LtCol James Tyson, USAF, JTAMDO

A Methodology for Establishing, Assessing, and Quantifying Family of Systems Interoperability Requirements for Alternative Theater Air Missile Defense BMC4I SR Architectures
Dennis Mensh, Michael Leite, and Julianna Ko; PRC Inc.

Information Filtering Based on CCIRs
Dr. Michael Proctor, UCF; and Maj Rodney Lusher, USA, Ft. Leavenworth

Thursday, 1030 - 1200

Working Group Session 7C.. Room G-386

PredictingTelecommunications Traffic Routes from Incomplete Network Information
Michael B. Richey, and Melvin J. Sobotka; Booz-Allen & Hamilton

Verification and Validation of Wargame 2000 for C2 CONOPS Applications
Dr. Dale K. Pace, The Johns Hopkins University Applied Physics Laboratory

Modeling C4ISR at the Joint Campaign Level Warfight
LTC James A. Knowles, Ph.D., DISA

Thursday, 1330 - 1500

Working Group Session 8A.. Room G-303

Joint C4ISR Decision Support Center Modeling & Simulation Classification Tool
Harvey F. Graf, The Mitre Corporation; Dr. Russell Richards, The Mitre Corporation; and Deborah Kelly, OASD(C3I) DSC

C4I Analysis Across a DIS Network
CAPT Dave Smith, USAF, TACCSF; Michael Gray, TBE; George T. Cherolis, SRC/BDM

ADS and Analysis – Lessons from STOW 97
Colonel Gary Q. Coe (USA – retired), Institute for Defense Analysis

Thursday, 1330 - 1500

Working Group Session 8B.. Room G-306

Discrete Event Simulator for ISR Responsiveness Evaluation (DESIRE)
Maj Bruce S. Bishop, USAF, Air Force Studies and Analyses Agency

Analysis Methods for Complex C4I Systems
John S. Furman, The Mitre Corporation

Representing C4ISR in JWARS: Concepts, Models, and Issues
LTC Dan Maxwell, USA, OSD PA&E, JWARS Office

Thursday, 1330 - 1500

Working Group Session 8C.. Room G-386

Adaptive Architectures for Command and Control (A2C2): The Third Experiment
William G. Kemple, Naval Postgraduate School (NPS); David L. Kleinman, University of Connecticut; Robert Benson, NPS; Daniel Serfaty, APTIMA, Inc.; and Gary R. Porter, NPS

Determinants of Organizational Structure From a Military Operations Perspective
Susan Page Hocevar, William G. Kemple, Robert Benson, Susan G. Hutchins; Naval Postgraduate School

Drivers of Adaptation Within Military Architectures: An Empirical Evaluation
Susan G. Hutchins, William G. Kemple, Robert Benson, Susan P. Hocevar; Naval Postgraduate School

The DDD: A Team-in-the-Loop Software Tool for Performance Evaluation of Distributed Organizations
David L. Kleinman, Naval Postgraduate School; and Daniel Serfaty, APTIMA, Inc.

WG 6 – C4ISR – Abstracts
6A: Room – G-303; 6B: Room – G-306; 6C: Room – G386

Tuesday, 1030-1200

Working Group Session 1A.. Room G-303

Methods for Information Valuation

Professor Alan Washburn
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Information is playing an increasingly important role in warfare, so systems that provide information will compete effectively with conventional systems that provide firepower. Considering that all of these systems are expensive, what is the right balance? Answering that question will require the creative use of existing OR tools and the development of new ones that are specifically oriented to measuring the value of information. This presentation will review tools that are potentially useful, describing applications and limitations.

On Linking C4ISR Improvements to Increases in Military Effectiveness

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This presentation is an answer for those who continue to argue that there is no way to measure the contribution of C4ISR systems to military effectiveness and attempt to solve this deficiency by searching for new measures of effectiveness specific to C4ISR systems. The presentation describes an approach (The Recipe) for conducting benefits analyses for C4ISR systems using standard measures of effectiveness, that is, measures related to the commander's objectives. The recipe presented is simple in description but not necessarily easy in execution. Many things share this characteristic but that has not stopped Operations Analysts in the past nor should it now. Nevertheless, this recipe is workable and has been employed successfully in the real world of DoD acquisitions. The presentation provides some background to set the stage and then offers a well-defined approach or recipe for dealing with C4ISR systems (Systems That Don't Shoot). This approach is then illustrated by an example from a DoD COEA conducted several years ago which was well-received by its audiences. It should be noted that portions of the presentation were presented as a tutorial at the 64th MORS at Fort Leavenworth. The current presentation goes deeper into the specifics of the method and attempts to provide a clear understanding of the effort necessary for successful execution.

Contribution of C4ISR Systems to Joint Close Support

Patrick G. Smock, Senior Operations Research Analyst
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The Close Support End-to-End Assessment was recently conducted for the Joint Staff by the TRADOC Analysis Center. The purpose of the assessment was to identify effective mixes of capabilities, systems, munitions, and linkages that maximized the commander's combat power for the close support mission.

One of the objectives of the assessment was to identify contributions of C4ISR systems to achieving greater efficiency and responsiveness to the ground commander's immediate firepower support needs. This paper will focus on the results from the C4ISR portion of the assessment.

Tuesday, 1030-1200

Working Group Session 1B.. Room G-306

Reengineering the Wheel: Integrating System and Process Development

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The future of military decision making and system development will be one of concurrency and integration. Doctrine and personnel changes can no longer lag behind technology development. With commercial technology existing in life cycles of eighteen to twelve months, the economic factors alone dictate a change in process. Yet, the compelling factor of involving decision makers in the system development

process, may be more important. Having the right system for the operation, and the proper personnel to do the job is not a luxury, it is a necessity.

This presentation will deal with the four components which must be dealt with to produce the suitable environment for a successful future. The components are: (1) creating an understanding of the dependencies which exist between technology, doctrine, and personnel when a change is instituted or new development is initiated in any of the three. (2) Taking a fresh look at how the processes of Decision Making, Logistics, Operations Management, and ISR not only will work together, but how they will interrelate in the future to allow for simultaneous planning. (3) Continuing the discussion of the information matrix; its structure, function, and utility as an integrated environment. (4) Finally, I'll propose how we can use dynamic models to pull these components together in a tool that developers and decision makers can use concurrently to develop architectures which integrate technologies , doctrine, and personnel providing a low cost and effective way of implementing the new systems and processes.

A Framework for Evaluating Alternative System Architectures: A Proof of Principle

Dr. Louis Moore
Dr. Walter Perry
RAND

This work describes and demonstrates an analytic framework to assess the effectiveness of alternative systems architecture designs. The framework calls for the generation and evaluation of several alternative architectures using the network simulator OPNET to model the information systems and an exploratory analysis tool to evaluate the outcomes from runs of the simulation for the alternatives. The model and analysis presented in this briefing have limited operational relevance. They do not represent the definition and analysis of an actual or proposed system. The work, however, is based on a real problem — the level of detail and the data used are fictitious. In addition, not all processes are modeled accurately. Rather, the objective is to demonstrate a *proof of principle* and these simplifications make the process more understandable while not detracting from the analytic value of the work. Based on our work thus far we believe that this framework has the capability to help analyze communications network performance. The framework shows good potential to represent, evaluate, and analyze C4ISR networks and to tie information system performance to operational outcomes.

Modeling Alternative C4ISR Architectures

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TRAC (TRADOC analysis Center) is conducting the J6/DSC Sensor-to-Shooter – Battle Management Study which involves modeling alternative C4ISR Architectures. This joint battle management study examines the effects, at a campaign level, of C4ISR improvements encompassing parallel dissemination, common operational picture, and automated target weapon pairing. The joint battle management system includes the hardware, software, personnel, and facilities used to coordinate, deconflict, and synchronize rapid targeting and attacks when multiple components have the capability to locate, identify , track attack, and evaluate targets in overlapping areas of responsibility.

A modified Southwest Asia scenario is used. The scenario is started 24 hours earlier than original to enable the modeling of an air interdiction campaign with its associated sensors, shooters and targets. The scenario is joint in that it contains Army, Navy, Air Force, and Marine elements.

The study objective is to examine joint targeting architecture and model the effects of C2 losses. This presentation will discuss C4ISR modeling and simulation techniques and measures used.

Tuesday, 1330-1500

COMPOSITE GROUP A SESSION .... Room G-109

Wednesday, 0830-1000

Joint Session with WG 5 & 11 .... Room G-102

Naval Oceanographic Applications of Space Systems

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The Naval Oceanographic office (NAVOCEANO) is charged with acquiring and analyzing global ocean and littoral data to provide specialized, operationally significant products and services for warfighters, and civilian, national and international customers. Historically, the bulk of these data have been collected by NAVOCEANO's fleet of oceanographic survey ships. However, in 1987 NAVOCEANO

established the Operational Oceanography Center (now the Warfighting Support Center (WSC)) in order to provide near-real time oceanographic products to naval warfighters. The National Oceanic and Atmospheric Administrations's (NOAA's) Polar-Orbiting Environmental Satellites (POES) and the Navy's Geosat altimetry satellite were the primary sources of broad area, real-time oceanographic information in the late 1980s.

As the Cold War ended, NAVOCEANO continued to support deep ocean, "bluewater" naval operations, but rapidly increased its product line for the warfighter conducting and planning operations in littoral areas. Timely assessments of bathymetry, currents, visibility, temperature, and waves are critical parameters for these operations. During the last several years, NAVOCEANO has greatly expanded its use of commercial imagery (e.g. Landsat Thematic Mapper and SPOT imagery) to characterize the oceanographic component of the battlefield environment. The role of these and other space-based systems in producing NAVOCEANO products is described.

Recognizing the key role to be played by space-based remote sensing in conducting its core business over the next twenty years, NAVOCEANO has developed a strategic plan for remote sensing. The key components of the plan are described.

An Overview of Orbital Imaging Corporation's Satellite Imaging Services

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Orbital Imaging Corporation (ORBIMAGE) is a majority owned subsidiary of Orbital Sciences Corporation established to develop, launch, and operate commercial earth imaging satellites. ORBIMAGE is leading Orbital's entry into the expanding market for satellite-based Earth imaging services.

ORBIMAGE will employ a uniquely integrated global system of imaging satellites, ground stations and Internet-based sales channels to collect, process and distribute its imagery products. ORBIMAGE currently operates OrbView-1, an atmospheric monitoring satellite launched in 1995 and OrbView-2 launched in August 1997. OrbView-2 carries the SeaWiFS instrumen, a land-ocean color multi-spectral payload which imagesmost of the earth's surface on a daily basis. The satellites are operated from our Dulles, VA satellite and mission operations center. OrbView-2 represents a unique government-comercial collaboration in which SeaWiFS was developed and flown under terms of an advance data purchase agreement with NASA. ORBIMAGE is now developing commercial products for SeaWiFS such as precise fish-finding maps for the fishing industry.

ORBIMAGE is currently developing the OrbView-3 & 4 spacecraft –systems designed to provide high-quality one meter resolution panchromatic imagery and four meter resolution multi-spectral imagery. ORBIMAGE was also recently awarded a contract by the U.S. Air Force for the development and operation of the "Warfighter-1" hyperspectral imaging payload to be flown on OrbView-4. OrbView-3 & 4 are scheduled for launch in 1999 and 2000, respectively.

ORBIMAGE is actively developing commercial applications and customers for all OrbView imagery products. Product applications include markets as diverse as precision agriculture, mineral exploration, mapping, and national security. We are focused on meeting future government imagery requirements addressable by OrbView-3 & 4 in a manner that provides substantial cost savings to the government. This provides the dual benefit of expanded markets for comercial suppliers while allowing the government to focus their investments on systems servicing the most stressing government-unique needs.

This presentation will focus on the design, operations, and products of our commercial imaging systems.

EarthWatch, Incorporated

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Commercial Remote Sensing Can Change the Environment of Military Forces

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Approved abstract unavailable at printing.

Wednesday, 1030-1200

Working Group Session 4A.. Room G-303

The Necessity for Integrating Space Assets into Campaign Analysis

James R. Hunter, Capt, Chief, Detailed Campaign Analysis
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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, & analysis (MS&A) community must take a hard look at the design and implementation of the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Measuring Dominant Battlespace Awareness to Support Force Mix Analysis of Imagery Systems

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Approved abstract unavailable at printing.

Overview of FY98 DSC Studies

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The mission of the DSC is to conduct analysis to support requirements and acquisition decisions leading to the fielding of the C4ISR System of Systems. The DSC Senior Steering Group includes the VCJCS, ASD(C3I), and USD(A&T).

This presentation will provide an overview of the DSC and its major study efforts for FY98 including: Moving Target Indicator (MTI) Radar Analysis; Dissemination of NTM Intelligence Sensor Information; Precision Force C4ISR Architecture Analaysis; and Reengineering the C4ISR Interoperability Process.

Wednesday, 1030-1200

Working Group Session 4B.. Room G-306

Entropy Based Warfare: The Mathematics For a Unified Theory Of Modeling the Revolution in Military Affairs

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One of the great analytic and technical challenges is how to properly evaluate the future organizational, doctrinal, and technological concepts that are the raison d'être of the evolving Revolution in Military Affairs. Current models of conflict are based on Lanchester's equations (linear and square law). These algorithms calculate rates of attrition based on the relative size and firepower of the contending sides configured as a linear duel between contesting opponents. Although extensive and sometimes elegant expansions of these equations have been developed over the last 80 years, no value can be ascribed to any concept or technology unless it has a direct attrition impact. Due to the limitations of the attrition paradigm all concepts and attributes of information advantage must ultimately be transformed, sometimes through tortuous logic, into an attrition variable. The ugly truth is that historical validation of these equations is thin and usually achieved through a constant creation of variables to balance the historical record against this attrition paradigm. Fundamentally, Lanchester's equations and its derivatives remain an attractive notion that has never truly paid off.

This paper will establish a new mathematical paradigm for conflict which will both cover the full spectrum of conflict and be scaleable to any sized conflict through the application of a new metric with supporting algorithms. This new modeling paradigm is predicated

on the historical view that warfare can be directed against the cohesion of enemy units or states rather than exclusively against the physical components that comprise those entities. In the context of this paradigm, the goal of forces is to disorder the enemy while maintaining their own cohesion. Certainly the destruction of an enemy force can accomplish this, but there are other dimensions that can now produce the same impact. The authors enlists a physics metric, entropy, to describe the state of disorder imposed on a military system at a given moment. Broadly, this metric is based on the fact that military forces are trained — and required — to act in a cohesive and organized manner. In conflict, a military force is subject to various pressures that create disorganization. In this paradigm, a military unit that has been whose entropy has risen to the maximum level is no more than a mob. The mechanism by which enemy disorganization and ineffectiveness are measured is entropy. The organized application of the entropy metric is the foundation of entropy-based warfare.

Modeling With a Lack of Intelligence

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Battle Damage Assessment (BDA) error can be classified in two ways: 1) The target is dead but believed alive and 2) The target is alive but believed dead. The Combat Forces Assessment Model (CFAM), used to determine munitions and aircraft purchases, currently evaluates the first type of BDA error. The second type of BDA error has been introduced into CFAM to determine its effect on the allocation of sorties, the use of weapons, and the length of the campaign. A parametric study of this error has been conducted to establish at what point this error becomes significant to the completion of the campaign.

The Use of Fuzzy Logic in Composite Threat Assessment

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The problem of determining a unit's vulnerability to multiple threats is complicated by the uncertainty associated with threat entity data, as well as the difficulty in combining the threat levels posed by each individual threat entity into a single composite threat metric. Along with the well-known difficulty in addressing these issues, there is a growing desire to incorporate such considerations as training level, capability, and hostile intent. These particular metrics are extremely difficult to address using traditional mathematical approaches. In addition, many mathematical approaches to combining threat vulnerability fail to adequately retain the commander's intuitive, experience-based "feeling" for threat levels. To address these shortcomings we have developed an approach that uses fuzzy logic to address entity threat assessment, an algorithmic method to determine cumulative threat assessment, and a visualization method to assist in tactical decision making. This presentation provides a description of this approach, as well as a practical example based on a hypothetical submarine mission.

Wednesday, 1330-1500

Working Group Session 5A.. Room G-303

Measuring Dominant Battlespace Awareness to Support Force Mix Analysis of SIGINT Systems

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Approved abstract unavailable at printing.

Analyzing the Military Worth of SIGINT Geolocation Accuracy

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The Intelligence, Surveillance and Reconnaissance Technical Planning Integrated Product Team has examined the ISR mission area

and described deficiencies relating to some part of the ISR process. One of the key issues is the geolocation accuracy of Signals Intelligence (SIGINT) systems which, in their current state, can not support precision weapon targeting. This study delved into what happens in combat when SIGINT geolocation accuracy is better than the present situation. The issue was examined using a combination of simulation tools which produce measures of effectiveness in the realm of military worth.

EADSIM was used to evaluate attack mission effects of improved SIGINT geolocation accuracy on weapons effectiveness, the ability of an attack aircraft to acquire and prosecute an attack on the basis of SIGINT information, and the effects on enroute survivability. Results showed that if the sensor error characteristics are known, a firm judgment can be made as to whether more information is required to attack a target or if the current information is adequate. In general, a weapon with a 40 M lethal radius employed against an emitter target will usually require a 80 to 100 meter Target Location Error (TLE). Armored or reveted emitter targets generally require a 10 to 30 meter TLE. For target acquisition, the results suggest there are few difficulties when the target location error is less than 200 meters. When factors such as weather or flight profile are introduced, the target location error is more critical. In the realm of survivability, TLEs of less than 1,000 meters have little affect on air attrition, and at location errors of greater than 1,000 meters, the particular surface to air missile system's lethality is the driving factor.

THUNDER extended the results derived at the mission level to determine if TLE derived from SIGINT systems had an effect on a longer conflict. For the 60 days of combat evaluated, there were no significant differences in the standard measures of effectiveness used in campaign level analysis. Enemy ground forces movement and attrition, enemy airpower statistics, and destruction of enemy SAMs were not greatly influenced by SIGINT derived TLE. SIGINT geolocation accuracy did cause noticeable differences in the number of enemy tactical SAMs destroyed early in the campaign. Because of this increased level of destruction, the friendly air forces suffered fewer losses, which allowed them to generate more sorties and reduce the cumulative number of sorties flown by enemy aircraft. Differences were also noted in munitions usage in that more precision weapons were used against emitter targets as the SIGINT geolocation accuracy improved.

Inter-Sensor Registration Requirements

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The ability to establish and maintain a Single Integrated Air Picture (SIAP) in a Joint Theater is strongly dependent on accurate inter-sensor registration (gridlock). *Yesterday's* gridlock capability (several degrees of angular uncertainty and a kilometer or more of translation uncertainty) has the potential for being dramatically improved (sub-milliradian (mrad) and less than 100 meters of angular and translation uncertainty, respectively). A consequence of striving toward improved gridlock is the question of diminishing returns; at what level of gridlock accuracy is further improvement no longer cost effective? It is known that other restrictions of SIAP clarity (i.e. methods for data handling, network data latency, network routing, and sensor correlation methods) will continue to hinder the generation of a SIAP despite gridlock accuracy improvements.

This paper examines the dependence of SIAP clarity on gridlock accuracy for various network connectivities of a joint theater situated in North East Asia. SIAP performance metrics were evaluated using the IDA developed J8 Architectural Assessment Tool (J8AAT), which is a statistical, semi-static model. The measurements of SIAP performance for airborne targets which were examined are dual track formation, handover accuracy, track merges (swaps), and track continuity. Results of this study indicate that there exists a value of gridlock for which there was a distinct *knee in the curve* response in the degradation of the dependent SIAP metrics. Threshold values of these gridlock accuracies are reported and shown to be independent of the network connectivity. Comparable results were obtained when the effects of data latency were examined.

Wednesday, 1330-1500

Working Group Session 5B.. Room G-306

Unmanned Aerial Vehicles (UAVs) as Communications Platforms

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This presentation provides an overview of analysis conducted for the Senior Steering Group (SSG) consisting of ASD (C3I) , USD (A&T) and the Vice Chairman of the Joint-Chiefs-of-Staff . The question posed by the SSG was; "What are the cost and benefits of using unmanned aerial vehicles (UAVs) as theater and tactical communication links in place of or in addition to satellite communication systems?" To explore the technical feasibility, operational effectiveness, and cost benefits for using UAVs in a communications role the analyses focused on three separate cases. The environment developed for the cases was a South West Asian scenario, with a six month duration, evaluating Strategic, Theater, and Tactical operations.

The NETWARS Model and Comm Burden Assessment Study of a Small JTF

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The J6 is currently building a new communications modeling environment called NETWARS (Network Warfare Simulation). This environment includes a commercial tool (OPNET), extended postprocessing capability and an extensive pre-processing tool. This tool will allow modelers and analysts to manage extensive amounts of data and allow for scenario reuse aimed at significantly reducing the time to conduct studies. This tool will allow CINC's, services and agencies to conduct detailed communications modeling of strategic and tactical networks in order to evaluate emerging technology, perform contingency planning and conduct communications burden assessments.

In order to evolve the NETWARS toolkit a study was used to assist requirements definition and to insure needed functionality is included in the toolkit. The study uses a Joint Task Force (JTF) scenario based upon the Unified Endeavour '98 exercise and includes elements of a Army Brigade, Marine MEU, Carrier battle group and AF Composite Wing. The purpose of the study, in addition to evolving the toolkit, was to conduct a communications burden assessment of a small Joint Task Force (JTF).

This presentation will provide an overview of NETWARS, to include screen shots from the Prototype Version 1.0 software deliverable and results from the comm burden assessment study of this small JTF.

Communication in JWARS and NETWARS

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. The author serves as a J6 representative to the JWARS. One responsibility is to provide liaison between the JWARS Theater Model and the Network Warfare Simulation (NETWARS) project that is creating a very detailed model of theater communications. The talk discusses how JWARS priorities were set for communications and how one might span the difference in the two model scales, a factor of about 4,000:1. NETWARS output is expected to provide delay times for JWARS communications.

Thursday, 0830-1000

Working Group Session 6A.. Room G-303

The Sensor-to-Shooter (Battle Management) Study

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The Sensor-to-Shooter series of studies have focused on improvements in communications linkages, devices, processors and message sets in order to facilitate the timely transfer of information between sensors and shooters in support of Joint Vision 2010. The focus of this presentation is on command and control processor improvements needed to support interoperability between the services. More specifically the analysis looks at material improvements to facilitate joint interoperability in order to: (1) share a common operational picture; (2) achieve parallel dissemination of information between sensors, shooters and battle management nodes; and (3) achieve joint weapon target pairing.

This presentation will discuss the methodology, the models, and the results of the analysis. Included will be a discussion of the issues analysis, development of MOE's and MOP's, use of Vignettes in the scenario, and the use of the Dynamic Architecture Assessment Tool (DAAT), the C4ISR model, and the Vector-In-Commander (VIC) model. Results are presented on the material alternatives that were considered and the final recommended battle management architectures.

Optimizing Assignment of Air-to-Ground Assets and BDA Sensors

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It has been difficult to analyze the tradeoffs between sensors that do bomb-damage assessment (BDA) and attack assets. The general feeling is that better BDA leads to fewer sorties and weapons expenditures, but this has been difficult to quantify. We present an analytical optimization model that directly assigns aircraft, weapons, and BDA sensors to targets. This model assesses the campaign contribution of all these resources, and can be used to analyze the tradeoffs between advanced weapons and improved sensors. We will show computation results with representative campaign data.

US/UK Sensor-to-Shooter Coalition C4 Interoperability Study

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In the Fall of 1997, the US Joint Staff Director for C4 Systems (JS J-6) and the UK Ministry of Defence Director General of Information and Communication Services agreed to conduct a combined study effort to examine Sensor-to-Shooter (STS) C4 interoperability to support US/UK military operations. The study objectives include sharing operations research methodology to examine this complex area while developing high pay-off C4 improvements to combined warfighting. This study will build on four previous JS J-6 STS studies which focus on identifying high pay-off C4 improvements to support the joint warfighter. The study will begin with an analysis of lessons learned data bases and a warfighter survey to identify combined C4 interoperability issues. The study will identify combined C4 deficiencies from US and UK perspectives and develop mutually defined measures of effectiveness and performance to assess alternative C4 improvements. Specifically, the study will examine current C4 architectures used to conduct combined US/UK military operations in specific mission areas, such as close air support, artillery fire support, naval gunfire support, close and deep interdiction and maneuver. By mission area and specific vignettes developed to capture problem areas, each C4 architecture will be modeled for effects on weapons performance. The Vector-in-Commander model at the TRADOC Analysis Center, Ft. Leavenworth, the study will examine campaign effects (loss exchange ratios) of the baseline and alternative operational architectures impact on combined military operations. The model is being tailored to capture the benefits to coalition military operations of a combined operational picture, simultaneous parallel dissemination of target information to shooters and C2 nodes, and the value of an automated weapon target pairing tool. and associated costs to implement C4 improvements. The Joint Technical Architecture Framework For Analysis 2.0 will be used to capture operational, systems, and technical views of potential C4 architecture improvements. The Levels of Information Systems Interoperability (LISI) model will provide an effectiveness measure to analyze levels of interoperability. Results will be briefed to senior US and UK decision makers.

Thursday, 0830-1000

Working Group Session 6B.. Room G-306

C4ISR Impacts on Strike Warfare

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Previous studies of C4ISR have tended to focus on the value of solutions in specific areas (communications, C2, and intelligence) but have rarely focused on an investment's contribution to total force objectives. Recent examples include the Deep Attack Weapon Mix Study (DAWMS), C4ISR Mission Assessment (CMA), and Sensor-to-Shooter (STS). This study seeks to integrate the results and methodologies from these previous efforts. A primary purpose of this study is to measure the impact of selected C4ISR systems on total strike force effectiveness to support programmatic decisions.

This presentation summarizes analysis results presented to the DSC Senior Steering Group (VCJCS, ASD(C3I), USD(A&T).

Modeling Approach for Joint C4ISR Decision Support Center Study "C4ISR Impacts on Strike Warfare

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The Joint C4ISR Decision Support Center (DSC) recently completed a study of the impact of C4ISR on Strike Warfare. The performance of current and planned (2006) C4ISR architectures was analyzed in Northeast Asia and Southwest Asia major theaters of war. The analysis investigated how information provided by a C4ISR architecture affects the efficiency of the strike warfare mission of military operations in MTWs. The analysis quantified what information will be collected, how good it is, how timely, who got it and what could be done with it. Through this process the analysis sought to determine if improvements in C4ISR produce commensurate improvements in strike warfare—measured as fewer sorties flown, weapons used, and aircraft lost—for fixed campaign objectives. This paper will present the quantitative analytic method developed for the study to assess the value and impact of information on strike warfare. The analytic framework (models and data) will be described, including details of a Markov model developed to model the fusion of information to generate strike opportunities and maintain target tracks against mobile targets.

An Application of the Dynamic C4ISR Analytic Performance (CAPE) Model to C4ISR Effectiveness

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This study examined the contribution five planned C$ISR systems to the strike warfare mission. We used a high level analytical model of the "sensor-to-shooter" process to estimate the effects of the planned investments in a two-MRC scenario. The model results indicate that although the overall effects were not large for the campaigns, the effects were important for specific target types.

The analysis used a model constructed in the Analytica™ software, which can be characterized as a connected set of nodes that represent model variables inputs, outputs, parameters, and influencing factors. Nodes which influence each other - have a quantifiable relationship - are connected graphically. This graphical interface results in a model that is module, easy to navigate, visual, and self-documenting.

The planned C4ISR systems included improvements in sensors, processing of the information from the sensors, and communication of the information to the shooters. The model simulates the process, delays and constraints associated with sensing targets, deriving information on the targets, and distributing the information about the targets to C2 nodes and strike platforms. Reduction in communication time delays, delays in processing of information and increases in the capacity to transmit and process information resulted in an increase in the number of targets available for selection by the strike assets and a better selection of targets to attack. The model was particularly useful in examining the relative contributions of - and tradeoffs among - weapon and plaform performance parameters, and C4ISR capabilities.

Thursday, 1030-1200

Working Group Session 7A.. Room G-303

A Methodology for Assessing Programmatic Viability of Joint C4ISR Systems

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The Joint C4ISR Battle Center (JBC) is responsible for identifying high payoff joint C4ISR system (or technologies) and making programmatic recommendation to the Joint Requirements Oversight Council (JROC) for accelerated development/fielding or improvement. To do so, JBC must assess the candidate systems and their development activities, including maturity, operational utility, and "jointness." Program Viability - the likelihood of successfully developing, and supporting the fielding of, a system or technological capability within defined finding, schedule, and performance requirements – is a key indicator of a candidate's maturity. However, attributes representing Program Viability are nor always tangible and thir measurements usually not easily quantifiable.

This paper describes a methodology developed by the Institute for Defense Analysis (IDA) for the JBC for assessing the Programmatic Viability of candidates. The methodology identifiesthe specific characteristics and attributes, and their associated metrics, that indicate the likelihood of a system being successflly developed, fielded, and supported when deployed. The application of the methodology was demonstrated using the Common Operations Modeling, Planning, and Simulation Strategy (COMPASS) project as an illustration.

Information from the illustrative assessment was subsequently used by the JBC as the basis for a formal assessment of the COMPASS projects's programmatic viability. The methodology has since been incorporated by JBC into its assessment guidelines along with appropriate methodologies for assessming the other aspects of the candidates' quality.

Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP) Requirements Analysis

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The Grenadier Beyond-line-of-sight Reporting and Targeting (BRAT) device is a small, lightweight, manportable transceiver that receives location information from Global Positioning System satellite broadcasts and transmits unit identification, location, and other desired brevity coded messages to higher headquaters' command and control systems. Signals are related form Grenadier BRAT devices through existing satellite, aircraft, unattended aerial vehicle, aerostat, or tower systems.

The Grenadier BRAT Warfighting Rapid Acquisition Program Requirements Analysis was commissioned by the Battle Command Battle Laboratory – Fort Leavenworth in May 1997. The objectives of the analysis included:

- Determine Grenadier Brat system-level capabilities and limitations, including capabilities of existing communications relay systems to process additional transmissions for Grenadier BRAT-equipped units.

- Evaluate the potential value of Grenadier BRAT's contribution to Army deep force situational awareness, with emphasis on corps-sized forces in multiple warfighting scenarios.
- Based on the previous evaluation, develop preferred quantities of systems for distribution within the Army force structure.

To meet the objectives of this study, TRAC and BCBL conducted a MAPEX to examine two approved operational scenarios based on TRADOC's Division Design Analysis.

Candidate distribution plans were developed for each scenario and evaluated in the MAPEX in order to develop a recommended preferred distribution of systems. This paper documents the results of the study effort.

Cause-And-Effect Experiments in Warfare Modeling and Simulation: C4ISR Impacts

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Two of the major challenges in assessing the sensitivity of combat outcomes to space system performance are (a) capturing sufficient cause-and-effect fidelity, and (b) making the cause-and-effect linkage between inputs and outputs understandable and believable. The purpose of the present work is the development of an experimental testbed for warfare modeling that will drive the necessary cause-and-effect insights needed for campaign simulation upgrades. This is a quick-reaction, rapid prototyping capability that allows modelers to test and experiment with a variety of ways of capturing fundamental cause-and-effect mechanisms needed for warfare modeling, in order to understand how these mechanisms can be incorporated into campaign-level models and simulations. Some of the main features of this experimental capability are: (1) The primary segments of the cause-and-effect chain, i.e., (a) Scenario, Environment; (b) Surveillance Architecture; (c) Communications; (d) Data Processing, Fusion, and Exploitation; (e) Strategy, Tactics, Doctrine; (f) Concept of Operations; (g) Combat Attrition; (h) Logistics: (2) Representation of decision processes by means of autonomous agent technology; (3) Simultaneous propagation of both continuous activities (e.g., motion through space and time) and discrete events (such as sensor updates, report arrivals, or target engagement/disengagement); (4) Stochastic, nonlinear models as appropriate; (5) An underlying conceptual structure that facilitates clarity and simplicity in modeling; (6) Ease of experimentation and model changes.

The results of a number of cause-and-effect experiments will be presented, together with the accompanying insights gained by means of this capability.

<u>Thursday, 1030-1200</u>

Working Group Session 7B.. Room G-306

InterPRO – Joint Theater Air and Missile Defense Interoperability Analysis

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The Joint Theater Air and Missile Defense Organization (JTAMDO) is responsible for planning, coordination, and oversight of joint integrated Theater Air and Missile Defense (TAMD) operational requirements and serves as the focal point for combatant command, Service, and Joint Staff Warfighter collaboration for requirements generation and joint operational concepts, JTAMDO has published a fully integrated TAMD BMC$I Joint Architecture, an overarching vision and structure that serves as the basis for making architecture recommendations to improve TAMD BMC4I interoperability.

Supporting the architecture development activities, Schafer Coperoration has developed for JTAMDO a <u>web-based</u> joint TAMD interoperability analysis tool – interPRO, which permits Warfighter/analysts to address the detailed facts that comprise the joint TAMD BMC4I Operational Systems and Technical Architectures through the use of an advanced, user-friendly human-computer interface; interPRO addresses information exchange requirements (IER) for inter-system (and inter-Service) compatibility and interoperability and supports Warfighter force deployment planning. InterPRO, which also incorporates Joint Interoperablity Test Center (JTIC) interoperability assessment data, supports a wide range of analyses:

- Assessming communications connectivity between existing or notional TAMD systems.
- Associating activities (from the TAMD Operational Architecture) with existing TAMD Systems and identifying which IERs can and cannot be supported and the cause of the deficiency and, for those that cannot be supported, the activities affected.
- Assigning activities to a notional TAMD System and identifying which IERs can and cannot be supported and, for those that cannot be supported, the activities affected.
- Determining connectivity between existing and/or notional TAMD Systems, identifying where compatibility/interoperability does or does not exist, the cause of any deficiency and the affected IERs and activities.

This paper presents an overview of interPRO, demonstrates its analysis capabilities and illustrates how web-based technologies are being applied to support DoD analyses.

A Methodology for Establishing, Assessing, and Quantifying Family of Systems Interoperability Requirements for Alternative Theater Air Missile Defense BMC4I SR Architectures

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This paper develops basic concepts for the evaluations of Force, Battle Management Command, Control, Communications, Computers, Intelligence, and Surveillance and Reconnaissance (BMC4I SR), Interoperability of Family of Systems (FoS) architecture alternatives. The FoS interoperability requirements are determined from a Joint Forces perspective. The methodology employs Models and Simulations such as the Extended Air Defense Testbed (EADTB), Extended Air Defense Simulation (EADSIM), etc.

The methodology consists of a set of logical steps that are iterative by design. It provides insights and valid estimates of numerical measures of effectiveness and defines force requirements at several levels. *This process is not trivial; the expected level of effort could be significant.* The method consists of five basic stages necessary to achieve valid results. These stages are (1) determination of force level requirements, (2) determination of force level capability, (3) analysis of force level capability, (4) determination of FoS BMCFI SR requirements b y battle overviews, and (5) determination of force level BMC4I SR requirements – overall.

This methodology can be used by Program Managers for determining top level BMC4I SR requirements for individual FoS in the battle force. In addition, once FoS levels of performance have been defined, the methodology generates a quantitative data base that becomes a useful tool for FoS suite selection. Once alternative combat system suites have been defined, these suites can be analyzed in terms of FoS performance capability versus cost.

Information Filtering Based on CCIRs

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The proliferation of information makes finding the information critical to a timely decision more difficult. In high-pressure, high-stakes situations like those found in military combat, timely, accurate, critical information is essential to the decision-maker. Information overload can be detrimental to such a situation. Decision-makers empowered to make decisions that involve consequences for human lives are normally select individuals who have formal training prior to assuming these duties and a great deal of successful experience at lower levels in an organization. The use of simulation to train and refine these select individuals' skills and relevant decision-making processes is a well known strategy in fields like aircraft piloting and NASA astronaut training. Less recognized is simulation as a training strategy for refining these skills in military command situations. Decision-makers in these positions must refine skills that articulate high-value information requirements to focus staff and information resources to provide that information on a timely basis. Well-focused, accurate information requirements yield lower-volume, information-rich nuggets. Lower volumes of information enhance decision-maker efficiency if the lower volume still contains the critical information needed to make a successful decision. This research develops a prototype information filter that provides a viable component to a simulation-based training strategy for decision-makers.

Thursday, 1030-1200

Working Group Session 7C.. Room G-386

Predicting Telecommunications Traffic Routes from Incomplete Network Information

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This analysis and software development is designed to predict the proportion of an origin-destination (o-d) pair's traffic which will use each link, given incomplete information about the telecommunications network used. Local Exchange Carrier nodes are classified by an integer program. An over-constrained gravity model is resolved to allocate traffic among the o-d pairs. Each direct link's capacity is estimated from Markov chain analysis without inverting its matrix. An iterative algorithm simultaneously pushes traffic for all o-d pairs across the network until each link's proportion carried converges.

Verification and Validation of Wargame 2000 for C2 CONOPS Applications

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Wargame 2000, being developed by the Ballistic Missile Defense Organization (BMDO) at the Joint National Test Facility (JNTF), is intended to support warfighters in examining their CONOPS, doctrine, tactics, techniques, procedures, and plans for specified air and missile defense command and control infrastructures. Wargame is expected to have five modes (or kinds of application): 1) concept of operations

(CONOPS) development (expected to be the most commonly used mode or application), 2) CINC assessment and field exercise, 3) staff and operator familiarization, 4) architecture assessment, and 5) test and evaluation (T&E) support. Wargame 2000 will be the replacement for ARGUS (Advanced Real-Time Gaming Universal Simulation), which has provided useful ballistic missile defense war gaming capability over the past decade. Verification and validation (V&V) of Wargame 2000 is a daunting task. This paper/presentation will describe BMDO's V&V approach and will discuss issues related to V&V of a large human in control (HIC) command and control (C2) simulation as they relate to C2 CONOPS development and evaluation.

Modeling C4ISR at the Joint Campaign Level Warfight

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In June of 1995, the Defense Information System Agency (DISA) developed a Joint Command, Control, Communication, and Computer (C4) Intelligence, Surveillance, and Reconnaissance (ISR) federation using the Defense Modeling and Simulation Office (DMSO) High Level Architecture (HLA). The federation, appropriately called the C4ISR Model, is a new tool used in analysis to demonstrate the added value of information within a Common Operational Picture (COP) and the subsequent affect on decision making. In the Fall of 1997, the model began it's first analytical use supporting the Joint Staff (J6I) and the C4 Integration Support Activity Decision Support Center (DSC) in the Sensor-to-Shooter Joint Fire Support: Close Air Support Study by examining the volumetrics associated with two different C4 architectures. Expanding on the Joint Fire Support Study, the C4ISR Model supported the Joint C4 Battle Management Study by assessing the impact of different C4 Architectures have on the development of mass effects prior to the execution phase of a planned theater scheme of maneuver. In addition to supporting the J6 and DSC, the Naval Surface Warfare Center - Dahlgren used the model to demonstrate the added value of C4 supporting Theater Ballistic Missile Defense (TBMD) operations as defined by the four pillars of TBMD: Active Operations, Passive Operations, Attack Operations and Battle Management, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (BMC4ISR). This presentation will cover a description of the C4ISR Model, the process used to support a C4 study plan and finally, it will highlight of the results from the supported studies.

Thursday, 1330-1500

Working Group Session 8A.. Room G-303

Joint C⁴ISR Decision Support Center Modeling & Simulation Classification Tool

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In 1995, the C^4ISR Decision Support Task Force (DSTF) determined that there were many modeling and simulation (M&S) tools used to support C^4ISR analyses, but that the existing tools have significant weaknesses in areas important to C^4ISR modeling. As a consequence of this, the Joint C^4ISR Decision Support Center, under the guidance of the VCJCS, the ASD(C3I), and the USD(A&T), is building an on-line database of M&S tools with a two-fold purpose in mind:

- Assist users in selecting tools that meet their particular C^4ISR analysis requirements.
- Provide a comprehensive source of information to facilitate the assessment of C^4ISR M&S capability, reduce redundancies, and promote M&S reutilization.

In support of this effort, an M&S taxonomy and characterization tool have been developed to capture information about the capabilities of M&S applications. The tool facilitates collection of information currently unavailable in DoD M&S catalogs. It characterizes the capabilities of the models and simulations in a consistent and objective way using an object-oriented approach. Objects (ground, air, sea, and space) and C^4ISR Functions/Processes identify "what" is modeled, and the object attributes and modeling methods (Level of Aggregation, Movement, etc.) describe the "how" or level of detail to which the objects or functions are modeled. Together, the "what" and "how" capture and lead to an understanding of each model's capabilities.

This paper describes the M&S classification tool. The uses of the resultant database for tool selection and M&S capability assessment are also discussed.

C4I Analysis Across A DIS Network

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Many programs have successfully integrated Joint distributed simulations and real systems using DIS protocols to provide effective simulation of the Joint Warfare environment. Few programs have been able to fully analyze the events that occurred during these exercises or experiments. The Tactical Air Command and Control Simulation Facility (TACCSF) has established a simulation and data collection methodology, architecture, and analytical tool set capable of computing a robust set of C4I MOE/MOP for tests conducted on a DIS network linking virtual, and constructive simulations in a Joint virtual battle space. No new DIS PDUs or additional bandwidth during test execution is required. Each distributed site captures the required data from its simulations or systems during realtime and then does a simple reformat and transmits the data across the T1 to other sites. The data files from distributed sites are then merged in a MS Access relational database to generate a combined Trial Event History for analysis. Examples of key queries used for coordinate and time transformations will be shown. In addition a flow chart of the complex queries which merge truth location and identity information from DIS Entity State PDUs with the appropriate recorded TADIL messages (perceived information) will be discussed.

This presentation will cover the current state of TACCSF's ability to provide accurate and timely data collection on critical operational events to facilitate analysis of performance and effectiveness of Joint operational concepts or C4I systems being tested across a DIS network. Operational performance measures will be addressed from the perspective of an air and missile defense analyst.

ADS and Analysis - Lessons from STOW 97

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STOW 97 is an Advanced Concepts Technology Demonstration for demonstrating the effectiveness, efficiency , and potential of the Advanced Distributed Simulation (ADS) in facilitating the training and mission rehearsal objectives of the commanders and staffs of the Joint Task Force and its components. However, the STOW technologies have implications in areas beyond training that include analysis. On balance, the requirements for analysis are changing as the result of a new global environment and technological capabilities. This presentation uses lessons from STOW 97 to examine how ADS can and should support analysis in the future, given emerging analytical challenges that require new analytic methods and tools. Some particular analyses where ADS can have a substantial impact are identified - particularly information processes. STOW 97 was interfaced with several real world C4I systems including GCCS, MCS-P, CTAPS, AFATDS, JSTARS, and E-OPS. These interfaces permitted real world processes to interact with simulated events realistically. STOW 97 included sophisticated ways for communication between real world activities and simulated events that allows new ways of analyzing processes such as intelligence, battle damage assessment, resource allocation, planning, and logistics. For example, an air tasking order was implemented effectively in the simulation. Simulated aircraft commanders reported on mission completions. Intelligence agents, desiring more specific information about the damage could task sensors to look more closely. These included electronic and optical surveillance. Also, terrain analysis was conducted. This discussion is balanced with a consideration of the challenges of ADS. The presentation then considers the incorporation of ADS within a broader research plan highlighting some of the special properties of ADS that make it useful for analysis and some new analysis techniques that should be considered, particularly in experimental design. Also, some technological challenges are identified to improve ADS for analysis. The presentation advocates the development of new approaches to data analysis and a greater dependence on visualization vice statistical analysis.

<u>*Thursday, 1330-1500*</u>

Working Group Session 8B.. Room G-306

Discrete Event Simulator for ISR Responsiveness Evaluation (DESIRE)

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DESIRE is a fast-running, discrete event simulator that measures an ISR platform's timeliness in responding to ad hoc tasking. The analyst defines the airspeed, endurance and route for each platform, as well as a long-term schedule for takeoffs, downtimes, and alert times. At many random times throught the simulation, each platform is "asked" how long it would take to get to where its sensor could see a randomly occurring "pop up" target. Targets are selected from either a box or a target list. The "answer" considers such factors as positions of the platform and target, airspeed, sensor look angle, flight time remaining an time until next takeoff. Results can directly be read and graphed by Microsoft Excel. DESIRE is ideally suited for comparing overall responsiveness of various mixes of platforms with different flight and logistics characteristics, such as, for example, 3 U-2's versus 6 UAVs. A user's guide is available. DESIRE is written in FORTRAN 77, and runs on a Windows PC. The executable file occupies 189 kilobytes, and the data files need less than 50 kilobytes. All files, including the source code, are available from AFSAA "as is." A typical run time is on the order of tens of seconds. AFSAA is the model manager.

Analysis Methods for Complex C4I Systems

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The analysis of highly complex modern battlefield C4I systems is a non-trivial task and an underdeveloped science. C4I systems have traditionally been evaluated for effectiveness at the system level, by examining measures of goodness such as timely, accurate, and complete information delivery within the domain of the system alone. There are few or no good Measures of Effectiveness that directly correlate the performance of C4I systems to the combat effectiveness of the formations they control. As a result, the combat contribution of C4I improvements is often underestimated in traditional effectiveness

analysis. To be successful, analysis techniques must relate C4I system-level performance to battlefield outcomes gained by the parent organization. This presentation will describe techniques used to link C4I system performance, staff performance, and battle outcome during an analysis of the Army's Division Advanced Warfighting Experiment. These findings will be translated into lessons learned applicable to the general topic of analyzing large C4I networks. This paper establishes a methodology for the examination and quantification of the performance of C4I systems in an operational context. This methodology proposes second-order MOE that quantitatively link C4I systems capabilities to the battlefield efficiency of ground forces operations. The primary focus of the methodology is on tracing the execution of mission threads throughout the fabric of the battlefield during key phases of the battle, and thereby linking the system performance metrics of the C4I processes and hardware to the accomplishment of specific battlefield tasks. In this way the battlefield outcomes that are traditionally measured when assessing ground forces effectiveness can be directly linked to the C4I system performance characteristics.

Representing C4ISR inJWARS: Concepts, Models and Issues

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——The Joint Warfare System (JWARS) is the next generation of theater level campaign model, currently being developed in the Office of the Secretary of Defense for use by the Joint Staff, Warfighting Commands, and services. JWARS is an analytical model whose design requirements include the ability to provide a "balanced" representation of joint warfare. This includes representing explicitly the effects that changes in the Command, Control, Communications, Computer, Intelligience, Surveillance, and Reconnaissance (C4ISR) systems may have on a campaign success.

This presentation describes the concepts that are being used to represent C4ISR in JWARS. Additionally, the progress of the development effort and known modeling issues will be discussed.

Thursday, 1330-1500

Working Group Session 8C.. Room G-386

Adaptive Architectures For Command And Control (A2C2: The Third Experiment

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The Office of Naval Research (ONR) sponsored Adaptive Architectures for Command and Control (A2C2) research program is a multi-year, multidisciplinary effort that seeks to establish a body of knowledge in current and future joint command and control and develop and test theories of adaptive architectures. The program involves researchers from many government, academic and industry institutions including ONR, ALPHATECH Inc., APTIMA Inc., The MITRE Corp., Carnegie-Mellon University, The University of Connecticut, George Mason University, Michigan State University and The Naval Postgraduate School (NPS).

A basic premise of the A2C2 program is that organizational structure should somehow "match" the available resources to the mission (task structure), and that changes to the resources available or the task structure should in turn induce changes to the organizational structure. A2C2 researchers have evolved a model-experiment-model framework to examine this and other basic hypotheses and to collect data to improve the models. Central to the research program are a series of model-driven experiments with human organizations conducted at NPS.

This talk describes the model-experiment-model framework and the planning and conduct of the third A2C2 experiment, conducted at NPS in November 1997. Companion presentations discuss aspects of the analysis carried out at NPS and the Distributed Dynamic Decisionmaking (DDD) tool (an abstract, wargame-like simulator) that was used as the driver for all three experiments.

Determinants Of Organizational Structure From A Military Operations Perspective

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This presentation describes post hoc analyses done by participants in the third A2C2 experiment of the scenario task and environment. Duncan's (1979) model for determining appropriate organizational structure was used as the theoretical motivation for analyses. The data offer critical analyses done by operationally experienced military officers (rank 03 and 04) who used the theoretical model to critique the simulation-based architectures; they also provide recommendations for alternative architectures. These recommended alternatives extrapolate from the constraints of the experimental simulation to the "real" joint operational arena to which the A2C2 research intends to generalize. Critical organizational characteristics identified by these analyses should not only enlighten the interpretation of the participant teams' choice of architectures for the simulation but also provide guidance to the identification of critical parameters to be included in future experimental designs. (See the companion presentation by Kemple et al for details of the experiment.)

Drivers Of Adaptation Within Military Architectures: An Empirical Evaluation

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A central feature of the A2C2 research program is a series of model-based, human-in-the loop experiments. The third A2C2 experiment was conducted at NPS in November 1997 to investigate the adaptation of organizational structure in response to an unanticipated trigger event. Participants

played the initial scenario in one of two six-node architectures. A trigger event was then introduced (a significant loss of Joint Task Force assets), and at the end of a planning period, teams were asked to choose from one of three architectures. The choices were (1) their former architecture with reduced assets, (2) a five-node architecture, similar to their original architecture, with assets somewhat better distributed for the mission, or (3) a four-node architecture, quite different from their original architecture, with assets specifically distributed for the mission. Each team then played two additional scenarios, one in the architecture they choose and one in another, in a counter-balanced design. (See the companion presentation by Kemple et al for details of the experiment.)

This presentation will discuss results of analysis of data collected on participants' ratings of the three architectures on the principles of warfare, comparisons of these ratings with critical dimensions used by modelers to optimize the architectures, and feedback from military personnel who operated under these organizational architectures when responding to computer-driven scenarios.

The DDD: A Team-In-The-Loop Software Tool For Performance Evaluation Of Distributed Organizations

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This presentation will describe the Distributed Dynamic Decisionmaking (DDD) tool that has been used to examine team performance and processes for a wide spectrum of military C2 teams over an evolving 15 year period. Built to support model-based empirical research within a controlled laboratory environment, the DDD implements a flexible, synthetic decision environment in which limited resources must be allocated by human decisionmakers (DMs) to prosecute tasks (i.e., activities or "things to do") in a dynamic and uncertain environment. As such, the DDD requires the team to assess the situation, plan response actions, gather/share information, use resources to accomplish tasks, coordinate actions, share/transfer resources, etc., in a real-time distributed environment.

The DDD differs from most of the gaming simulators that exist today by virtue of its flexibility. Most team simulators are built with a task, information and command structure that replicates a specific military team task. The DDD, in contrast, was designed to capture the essential elements of many different C2 team environments, and allow the experimenter to manipulate such factors as team structure, access to information, control of resources, etc. Automated data recording, built into the DDD, includes a host of performance, process, and coordination measures for subsequent analysis and modeling activities.

The DDD is currently being used to examine emerging issues in Joint Command and Control, particularly those dealing with the interactions between task (or mission) structure, and the way in which the organization charged with the mission is itself structured. These applications will be reviewed by way of example.

Backups

Joint Composite Tracking Network (JCTN) and Defensive Counter Air (DCA) Connectivity Study

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The purpose of this study was to examine the military worth of adding a JCTN capability to DCA fighters. Air Force Studies and Analyses Agency, Battle Management / Command and Control Branch in the Force Analysis Division conducted this study. The Joint Theater Missile Defense Organization (JTMDO) and the Ballistic Missile Defense Organization (BMDO) jointly sponsored this analysis as part of the JCTN Phase 2B Study. The JCTN is a planned processing system that includes common software and hardware to share and fuse data from participating sensors to create a consistent, integrated aerospace picture. JCTN includes a communications element and is conceptually based on the Navy's Cooperative Engagement Capability (CEC). In order to provide a composite of contributing sensor(s), a number of difficult technical requirements (e.g. sensor gridlock, data association/correlation, measurement latency) must be achieved. The full JTAMDO/BMDO study assessed the technical feasibility of meeting these challenges. In the AFSAA study, three JCTN connectivity options were evaluated, all assuming that the existing AWACS, Patriot, Hawkeye and Navy Aegis systems were connected by a JCTN type of network. The first option provided a baseline measurement of planned capability called a Joint Data Network, conceptually based on the Joint Tactical Information Distribution System (JTIDS). The second option was to add a JCTN receive only capability to the DCA fighters. This enabled the fighters to 'see' the JCTN single integrated air picture. The third option was a fully integrated JCTN capability including the DCA fighters. The primary factors examined were DCA connectivity (JDN, JCTN Receive Only, and Full JCTN), Blue Force Level (low and medium blue forces) and a postulated Elevated Sensor (with or without). Measures of merit were collected for each factor (12 cases) and four model replications were conducted. The scenario is a North East Asia 2010 regional conflict. The timeline for the scenario incorporated an integrated air attack of enemy ground and air launched cruise missiles, bombers, and air-to-air fighters and theater ballistic missiles. Principle measures of effectiveness used to measure the system capability improvements were timeliness (time to: detect enemy, initiate track, identify enemy, engage enemy, and kill enemy) and event numbers (number of detections, initiations, identifications, engagements, and kills.) The goal of the study was to quantify the operational capability improvements provided by a JCTN for decision makers to determine future defense resource decisions.

A High Resolution Satellite Communications Model

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Information warfare is a cornerstone of Joint Vision 2010, which addresses the future strategic environment for the United States. An integral component of information warfare is the continuing development of joint space doctrine. The purpose of this presentation is to develop and demonstrate Simulation of Satellite Communications (SIMSATCOM), a high resolution, stochastic simulation of satellite communications for evaluating the effectiveness of message transmission and receipt by specified senders and receivers. SIMSATCOM is designed to operate as a stand-alone simulation, but may be adopted as a high resolution module for a large scale simulation. The presentation describes SIMSATCOM and provides analyses of simulation runs for different jamming levels and channel capacities.

WG 7 – Operations Research and Intelligence Analysis – Agenda

Chair: Miss Linda L. Weber, MITRE Corporation
Cochair: Mr. Lester W. Grau, Foreign Military Studies Office
Cochair: Dr. Allan S. Rehm, MITRE Corporation
Advisor: Mr. Peter A. Shugart, TRAC – White Sands Missile Range

Room: G-133

Tuesday, 1030 – 1200: Russian Forces
The Russian Military: Current Status and Future Prospects
Dr. Robert Arnett, HQ, Department of the Army

Forecasting Russian Military Forces in 2020
Mr. Raymond C. Ennis, Central Intelligence Agency

Tuesday, 1330-1500
COMPOSITE GROUP B SESSION... Room G-109

Wednesday, 0830-1000: Multinational and International Operations
The Use of Fuzzy Logic in Composite Threat Assessment
Mr. Anthony Cowden, Sonalysts, Inc.

Multinational Operations
Mr. Russel E. Myers, GTE Government Systems Corporation

Paradigm Shifts in Joint Task Force Intelligence Operations
Mr. Eugene D. Seiter, Jr., GTE Government Systems Corporation

Wednesday, 1030-1200: Foreign Studies

Tracking Down Russia's Lanchester
Dr. Jacob W. Kipp, Foreign Military Studies Office

Wednesday, 1330-1500: Modeling and Simulation
Examinations of Methods to Input Leadership or Other 'Soft Factors' into Models and Simulations
Mr. Gerald A. Halbert and Mr. Steven P. Ketterer, National Ground Intelligence Center

Development of an Analytical Tool for Assessing Military Intelligence Production: The Intelligence Production Model (IPM)
Ms. Marsha McLean, BDM International/TRW
Dr. Beverly G. Knapp and Dr. John Warner, Army Research Laboratory – Ft. Huachuca Field Element

Thursday, 0830-1000: Information Sharing and Information Operations
Information Sharing in Complex Humanitarian Emergencies and Other MOOTW
Dr. Charles J. Jefferson, National Intelligence Council

Intelligence Support to Information Warfare
CDR Erik Dahl, LT Kirk Luker and LT Wes Latchford, Fleet Information Warfare Center

Thursday, 1030-1200: The Value of Information, Two Perspectives
Methods for Information Valuation
Prof. Alan Washburn, US Naval Postgraduate School

Information, Intelligence, Knowledge and Combat Dynamics: a Meta-Model
LTC David Olwell and LTC Gary Krahn, US Military Academy

Thursday, 1330-1500: Advanced Technology Uses
Guerrillas versus Modern Armies: Panning for Gold in Panjshir
Mr. Lester W. Grau, Foreign Military Studies Office

ADS and Analysis – Intelligence Lessons from STOW 97
Mr. Gary Q. Coe, Institute for Defense Analysis

Alternates
Foreign Integrated Air Defense Systems – Generically Assessing Performance
Mr. David Panson, NAIC/GTI

Network Interdiction Tool
LCDR Philip S. Whiteman, USSTRATCOM

The Utility of OR in Intelligence Assessments: A Proof of Principle
Major John M. R. Henderson, National Ground Intelligence Center
Mr. Peter A. Shugart, TRAC/WSMR

WG 7 – Operations Research and Intelligence Analysis – Abstracts
Room: G-133

Tuesday, 1030 – 1200: Russian Forces
The Russian Military: Current Status and Future Prospects

Dr. Robert Arnett
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This presentation examines the Russian Armed Forces' current status and future prospects. It briefly reviews what has occurred to the military since the fall of the Soviet Union, including the Chechnya war. Was Chechnya a true reflection of the armed forces capabilities? To understand the current situation and future prospects, nine parameters are analyzed: defense spending, numerical strength, manpower quality, training, weapons procurement, logistics, maintenance, mobilization capability and morale. The presentation then discusses the prospects for military collapse, military coups, or the creation of regional armies.

Forecasting Russian Military Forces in 2020

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Central Intelligence Agency
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A critical element of long-term US military planning, the objective of the recently completed QDR, is an insightful forecast of important foreign military establishments. The Futures Team of the Russian Issues Group, Central Intelligence Agency, is developing a methodology for forecasting Russian military forces for the year 2000. This methodology, to meet the needs of US policymakers, must account for political developments in Russia as well as the future state of technology. It must also conform to economic realities of a future Russia, something that earlier force projection have not done well. Our proposed methodology is based n five sequential steps includes:

- The development of several political/economic futures scenarios from which economic and military analysts develop for each scenario and estimate of the availability of funds for defense spending and a corresponding defense posture description.
- A review by a panel of outside experts on Russian political and economic affairs to examine the realism of the resultant force posture descriptions.
- The development by forces analysts of force components to satisfy the requirements of each of the posture descriptions and by technical analysts to develop supporting R&D and industrial production programs.
- The costing of resulting force projections and the conduct of negotiations between the various forces, R&D, and production analysts to bring the resulting projections into budget.
- A review by a panel of outside experts on Russian military affairs and on technology to examine the results of the projection.

The presentation will discuss how our methodology is being used and some of the early results of our investigation.

Tuesday, 1330-1500
COMPOSITE GROUP B SESSION.. Room G-109

Wednesday, 0830-1000: Multinational and International Operations
Multinational Operations

Mr. Russel E. Myers
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The Goldwater-Nichols Act of 1986 and the creation of the US ATLANTIC COMMAND in 1993 have been major milestones in DOD's evolution to Joint Operations. Our military Services have learned a great deal about Joint operations from the hard lessons of Granada, Panama, Haiti and now Bosnia. Just when we think we are beginning to see the light at the end of the Joint tunnel, along comes Multinational operations.

In the original 34 page Joint Vision 2010 (JV2010) concept document, General Shalikashvili declares, "It is not enough just to be Joint...we must find the most cost effective methods for integrating and improving interoperability with allied and coalition partners." The Multinational challenge is continued in the May 1997 *"Concept for Future Joint Operations – Expanding JV2010"*. In May 1997, the Clinton Administration documented *"A National Security Strategy for a New Century"*. In this document, the principal threats to US interests are grouped into three categories: Regional or State-centered threats, transnational threats and threats from weapons of mass destruction. "No one nation can defeat these threats alone. Accordingly, a central thrust of our strategy is to adapt our security relationships with key nations around the world to combat these threats to common interests. We seek to strengthen cooperation with friends and allies...The U.S. military plays an essential role in building coalitions and shaping the international environment in ways that protect and promote U.S. interests." In July 1997, the ASD/C3I C4I Integration Support Activity (CISA) organized a Multinational Operations panel of CINC and Service representatives to document the key inhibitors that restrict multinational operations. Mr. Myers chaired that panel. The final report of the team made 17 specific recommendations to the DOD Architectures Working Group (AWG) related to Policy/Doctrine, Acquisition, Cultural Differences, Technology and Training/Exercises inhibitors.

This presentation will review the inhibitors to Multinational operations documented by the Multinational panel and confirmed during UE98-2 with a focus on intelligence information support to those operations.

Paradigm Shifts in Joint Task Force Intelligence Operations

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This presentation addresses the major shifts forced on today's JTF intelligence system to properly support low intensity combat operations and operations other than war (OOTW). Operation Uphold Democracy (Haiti) is presented as an example. Such operations are not focused on the nation's vital strategic interests, are under intense media scrutiny, and have little to no tolerance for casualties or mistakes. The intelligence must provide the necessary resolution in near real time to support its commander. The basic objectives of such operations have shifted from defeating an enemy to avoiding friendly casualties. Traditional tactical success, normally associated with defeating the enemy, has evolved into an assumption. Force protection, always a supporting task, has now become the primary mission. Intelligence operations follow. Friendly forces represent combat power, but also vulnerabilities - they are targets. Defeating even a weak enemy and accepting no friendly losses requires a new way of doing military business, including intelligence. The basic framework of intelligence operations remains unchanged, but the intensity and resolution of the entire process shifts to a far more rigorous standard. The traditional framework of "macro" intelligence analysis, bracketed from one level above to two levels below the friendly parent command, is now a micro analysis to track and identify any enemy capability to inflict friendly casualties. The intelligence system must mirror the JTF commander's framework of coupling strategic national objectives with very small tactical operations.

Wednesday, 1030-1200: Foreign Studies
The Use of Fuzzy Logic in Composite Threat Assessment

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The problem of determining a unit's vulnerability to multiple threats is complicated by the uncertainty associated with threat entity data, as well as the difficulty in combining the threat levels posed by each individual threat entity into a single composite threat metric. Along with the well-known difficulty to addressing these issues, there is a growing desire to incorporate such considerations as training level, capability, and hostile intent. These particular metrics are extremely difficult to address using traditional mathematical approaches. In addition, many mathematical approaches to combining threat vulnerability fail to adequately retain the commander's intuitive, experience based "feeling" for threat levels. To address these shortcomings we have developed an approach that uses fuzzy logic to address entity threat assessment, and algorithmic method to determine cumulative threat assessment, and a visualization method to assist in tactical decision making. This presentation provides a description of this approach, as well as a practical example based on a hypothetical submarine mission.

Tracking Down Russia's Lanchester

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With the publication of the translation of M. Osipov's "The Influence of the Numerical Strength of Engaged Forces on Their Casualties" by Robert L. Helmbold and Allan S. Rehm, the work of this contemporary of Lanchester became available to the larger operations research community. Osipov's work appeared in 1915 in the leading journal of the Russian War Ministry, Voyenniy sbornik [Military Digest]. As the translators pointed out in their introduction, "Osipov's most unique and important contribution is the explicit and systematic application to quantitative historical data of what, for his time, were fairly advanced formal statistical methods." While Osipov's contribution had been acknowledged in Russia and the West, very little is known about the author himself. When Helmhold and Rehm began their work on the translation of Osipov, they asked me what I knew about the author. My answer was, "very little." His article appeared only two years before the Russian Revolutions. The article itself contained no details on his background and career. The journal itself disappeared in the midst of revolutionary upheaval. Osipov became a name and not a person. However, over the last ten years, I have engaged in a protracted and frustrating search for Osipov's identity. Soviet analysts, historians, and archivists all suggested that Osipov was a pen name and not a real person. That, on the basis I have gathered from Russian archives and libraries, is incorrect. The author was one Mikhail Pavlovich Osipov, a Colonel in the Topographic Service of the Russian General Staff who was actively engaged in survey studies in Siberia and the Far East. The mathematical tools applied to those tasks, as reported in his publications, support the supposition that Colonel Mikhail Pavlovich Osipov and M. Osipov were one and the same person. The evidence is not complete and I am still trying to find the correspondence of the editor of Voyenniy sbornik to confirm the connection. I have had no luck in following Osipov's life and career after 1915. I propose to offer to the audience the evidence that I have marshaled to date on this topic.

Jacob W. Kipp is the author of the following relevant works: Foresight and Forecasting: The Russian and Soviet Military Experience. College Station, Texas: Center for Strategic Technology Stratech Studies, 1988; "Soviet Military Foresight and Forecasting in and Era of Restructuring," in: Derek Leebaert and Timothy Dickinson, eds., Soviet Strategy and New Military Thinking. New York: Cambridge University Press, 1992, 248-275; and "Soldiers and Civilians Confronting Future War: Leo Tolstoy, Jan Bloch and Their Russian Military Critics," in: Stephen D. Chiabotti, ed., Tooling for War: Military Transformation in the Industrial Age. Chicago, Imprint Publications, 1996, 189-230.

Dr. Kipp argues that the Osipov of the famous Voyenniy sbornik article was none other than Colonel Mikhail Pavlovic Osipov of the Topographic Service of the Russian General Staff. Dr. Kipp bases his argument on the review of Colonel Osipov's published works in the decade prior to the appearance of this article in 1995 and suggests that the mathematical apparatus used in these preceding works supports this conclusion.

Wednesday, 1330-1500: Modeling and Simulation
Examinations of Methods to Input Leadership or Other 'Soft Factors' into Models and Simulations

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Analysis of past conflicts, troop or strategic leadership has consistently been mentioned by historians as affecting the outcome of battles, campaigns, and wars. The majority of models and simulations used to examine battles and campaigns are well developed and fairly accurately portray the effects of weapons and the maneuver of units on the outcome of engagements. However, these models and simulations do not normally include consistent methods of evaluating the effects of leadership at various levels, and the effect of good (or bad) leadership on battle outcome. In the 21st Century, we must be able to model the impact of soft factors.

Recently, several groups of analysts have been studying methods to assess the importance of leadership in battle and to develop ways in having these appraisals numerically evaluated so they may be used as inputs in the models and simulations. The TASC Corporation has developed the PERSPOT model to evaluate several soft factors and integrate the effects to allow input of soft factors to the TASFORM model. Analysts at the National Ground Intelligence Center (NGIC) have developed a method to use their leadership evaluation methodology to provide input to PERSPOT and similar sub-models for other models and simulations.

While additional research needs to be done to quantify the effects of leadership and other soft factors such as degree and level of training, or morale and cohesion, there is a need to explore this area by the modeling and simulation community. This presentation discusses a specific approach being explored to improve models and simulations by including information about leadership.

Development of an Analytical Tool for Assessing Military Intelligence Production: The Intelligence Production Model (IPM)

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The objective of this effort was to develop an analysis framework and computer-based tool for simulating, and evaluating the impacts of materiel, organizational, and personnel changes to the military intelligence (MI) production system. This tool was designed to assist the MI community to assess new concepts for meeting commander's intelligence requirements of the future.

A series of representational models--conceptual, performance, and information quality-were built first. The conceptual model represented intelligence production as a simple input-process-output system, with nodes representing the functions required to produce intelligence, and links representing the information flow. The performance model specified the behavioral tasks required to produce intelligence, a taxonomy of human performance errors associated with the tasks, and the operational, scenario, and environmental variables that affect task performance. Finally, the intelligence quality model quantified the results of information flow activity and the impact of task performance variables when operating on the information.

A team of experts in behavioral science, modeling and simulation, and military intelligence built the IPM. The computer-based IPM was then implemented by linking these models using a rule-based logic structure, and accessed by a user interface designed to allow analysts to conduct case studies for a wide range of evaluation questions. Currently, the IPM runs in a windows-based PC-environment, and is being applied to a number of questions raised by the MI operational community.

Thursday, 0830-1000: Information Sharing and Information Operations
Information Sharing in Complex Humanitarian Emergencies and Other MOOTW

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The author's basic premise is that in order to make effective use of the available information, there needs to be an institution charged with knowing 'who knows what,' and procedures for obtaining that information in a useable form and sharing or pooling it so that all relevant users can have ready access. The purpose of the paper is to survey what is being done to establish such a system and to point to emergent issues which need to be addressed.

The requirement for such a study is implicit in the findings of the recently published final report of the Carnegie Commission on Preventing Deadly Conflicts:

> "... there are no mechanisms in place for governments or the decision- making bodies of the major regional organizations to acquire systematically the information that international and national NGOs, religious leaders and institutions, the business community, or other elements of civil society have accumulated from years of involvement. Moreover, few habits and practices have been developed to encourage such an exchange."

In addition to describing efforts under way to enhance information sharing and identifying issues needing to be addressed, the paper will expand on the author's previous work regarding 'what do we need to know' and 'information sharing considerations.' In the paper "Troubled States in Today's World" presented at the 2nd International Low Intensity Conflict Workshop (Stockholm, June 1997), the latter were characterized as being relatively straightforward in principle, but nonetheless somewhat difficult in practice:

> "Issues that must be taken into account in sharing information are mostly rather straightforward: is the information valid (i.e., accurate and actually from the stated source), timely and in a useable form? Standardization is highly desirable, but by no means easy to obtain. NATO, which has been working hard at a variety of standardization issues for half a century, still has lots of work to do. The toughest issues, however, revolve around sensitivities of various players to being openly involved with each other, and specifically to sharing information."

The author will gather information for the paper over the next several months in a series of meetings and interviews with key persons in Washington and New York. Institutions with which preliminary contact regarding this project have been established include several offices at AID, several bureaus at the State Department, the U.S. Institute for Peace, the Carnegie Commission for the Prevention of Deadly Conflicts, and the humanitarian NGO coordinating body InterAction.

Intelligence Support to Information Warfare

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Numerous documents and publications have stated that Information Warfare (IW) will make great demands on the intelligence community. Some liken it to the intelligence needs of Special Warfare: just as a SEAL may need to know which way the door knob turns, an information warrior may need to know what kind of computer an adversary uses, what newspaper he reads, etc.

Captain Sherrard recently wrote in *Proceedings* about the critical role Naval Intelligence must play in IW: "Entire new databases will need to be developed and filled with intelligence data that are current and accurate, and have a degree of specificity not now required to drop a 500 pound bomb. From a defensive IW posture, detailed intelligence collection will be focused on indications and warnings of IW attacks on our own information.... Will we have the means to detect and neutralize an IW attack?"

This briefing provides an overview of the key organizations and systems involved in providing intelligence support to IW. It highlights some of the critical issues and concerns of IW from a naval intelligence perspective. While it is a naval-oriented briefing, many of the intelligence concerns can be easily generalized for the intelligence community at large.

Thursday, 1030-1200: The Value of Information, Two Perspectives
Methods for Information Valuation

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Information is playing an increasingly important role in warfare, so systems that provide information will compete effectively with conventional systems that provide firepower. Considering that all of these systems are expensive, what is the right balance? Answering that question will require the creative use of existing Operations Research tools and the development of new ones that are specifically oriented to measuring the value of information. This presentation will review tools that are potentially useful, describing applications and limitations.

Information, Intelligence, Knowledge and Combat Dynamics: a Meta-Model

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The Department of Mathematical Sciences at USMA is undertaking this research for the Army Digitization Office. We are working from both first principles and extensive simulations on previously validated combat models to try to model the effects of data, information, and knowledge on combat dynamics. There are significant interactions that are not easily modeled and which we feel need to be understood. We are building a simple model based on designed experiments using combat simulations across a suite of scenarios. Our goal is to be able to provide a framework for assessing how digitization (which can be thought of as machine enhanced processing of data into information, and dissemination / filtering of that information) fits into an analysis of combat dynamics. The goal is not to exchange data better: the goal is to win our nation's wars. This means we wish to use combat "results" as our response, not any intermediate variables.

We use a boxing analogy to explain why interactions are important. If I am fighting Mike Tyson, it doesn't affect the outcome if I know exactly what punches he intends to throw, and when he intends to throw them: the overmatch makes it moot. If I am fighting my brother (similar size and ability), it makes a big difference. And from Tyson's point of view, it doesn't matter if he knows my plan or not. The value of information depends on the forces and the situation. The point is that there is a response surface for the distribution of combat outcomes by information, intelligence, and data, as well as the usual predictors, and the gradient for that surface is a function of these and the other inter-related predictors. The optimal solution varies with the situation, and we want to make a first cut at modeling that.

The short-term benefit is to provide some insights on where the maximum benefit per dollar can accrue, and where the points in the C4 net that need the most protection are. The long-term goal is to better understand combat models and combat.

This is a multiyear project that we just launched. We expect to have some preliminary results to share by June. We look forward to a lively conversation from the audience.

Thursday, 1330-1500: Advanced Technology Uses
Guerrillas versus Modern Armies: Panning for Gold in Panjshir

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When forecasting future war, emerging technologies play a dominant role as military planners integrate geo-strategic realities, national interests, developing alliances and existing armed forces with the uncertainties of the future. Since technological advances have had a major impact on the warfighting of the past, it is prudent to plan for the incorporation or nullification of future technologies before and as they appear. Such future technologies have the most application in fighting a conventional, maneuver war against a modernized, but less-technologically advanced armed force. The leverage technology offers depends on the circumstances shaping combat such as the theater, the opponent and the objective. Technology offers little decisive advantage in guerrilla warfare. An effective way for a technologically less-advanced country, or a faction within that country, to fight a technologically-advanced country or coalition is through guerrilla war. Guerilla war, a test of national will and the ability to endure, negates many of the advantages of technology. What is not necessary in guerrilla force and the continued will to outlast the enemy over the course of decades. The side with the greatest moral commitment, be it patriotic, religious or ideological, will eventually win through higher morale, obstinacy and survival.

Mr. Grau's book, The Bear Went Over the Mountain: Soviet Combat Tactics in Afghanistan examines Soviet small unit tactics from the Soviet perspective. He and Mr. Ali Jalai's book The Other Side of the Mountain: Mujahideen Tactics in the Soviet-Afghan War examines guerrilla war from the guerrilla's perspective.

Mr. Grau argues that modern, high-technology forces are still in peril when committed to fight guerrillas. Modeling and developing norms for such combat is difficult, but these case studies provide a base line.

ADS and Analysis – Intelligence Lessons from STOW 97

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STOW 97 is an Advanced Concepts Technology Demonstration for demonstrating the effectiveness, efficiency, and potential of the Advanced Distributed Simulation (ADS) in facilitating the training and mission rehearsal objectives of the commanders and staffs of the Joint Task Force and its components. However, the STOW technologies have implications in areas beyond training that include analysis. On balance, the requirements for analysis are changing as the result of a new global environment and technological capabilities. This presentation uses lessons from STOW 97 to examine how ADS can and should support analysis in the future, given emerging analytical challenges that require new analytic methods and tools. Some particular analyses where ADS can have a substantial impact are identified - particularly information processes. STOW 97 was interfaced with several real world C4I systems including GCCS, MCS-P, CTAPS, AFATDS, JSTARS, and E-OPS. These interfaces permitted real world processes to interact with simulated events realistically. STOW 97 included sophisticated ways for communication between real world activities and simulated events that allows new ways of analyzing processes such as intelligence, battle damage assessment, resource allocation, planning, and logistics. For example, an air tasking order was implemented effectively in the simulation. Simulated aircraft commanders reported on mission completions. Intelligence agents, desiring more specific information about the damage could task sensors to look more closely. These included electronic and optical surveillance. Also, terrain analysis was conducted. This discussion is balanced with a consideration of the challenges of ADS. The presentation then considers the incorporation of ADS within a broader research plan highlighting some of the special properties of ADS that make it useful for analysis and some new analysis techniques that should be considered, particularly in experimental design. Also, some technological challenges are identified to improve ADS for analysis. The presentation advocates the development of new approaches to data analysis and a greater dependence on visualization vice statistical analysis.

Alternates

Foreign Integrated Air Defense Systems – Generically Assessing Performance

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Approved abstract not available at printing.

Network Interdiction Tool

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The Utility of OR in Intelligence Assessments: A Proof of Principle

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WG 8 – INFORMATION OPERATIONS/INFORMATION WARFARE – Agenda

Chair: Lt Col Steve Mahoney, OSD(C3I)/IO
Cochair: Dr. John H Brand ,US Army Research Laboratory
Cochair: Ms. Jean Kopala, ANSER
Cochair: Capt Ken Haertling, AFIWC/SA
Advisor: Donald W Kroening, US Army TRAC-SAC
Advisor: Dr. Paul E. Girard Science Applications International Corporation
Room: G-018

Tuesday, 1030 - 1200
Introduction - Lt Col Mahoney, OSD(C3I)/IO

IO Modeling and Simulation (Classified)
Mr. Steve Stigall

Use of Fuzzy Logic in Composite Threat Assessment
Mr. Anthony Cowden, Sonalysts Inc.

Tuesday, 1330-1500
Joint Session with WG 8 & 28 .... Room I-122
Decision Analysis and Intelligence and IO
Dr. Dennis Buede, Mr. Terry Bresnick

Value Driven MOE for IO
Captain Michael Doyle, Dr. Richard F. Deckro, Lt Col Jack A. Jackson, LTC Jack M. Kloeber, AFIT

Allocating the Threat
Mr. Peter C. Byrne, Mr. Richard E. Rosenthal, Captain Brian Widdowson

Wednesday, 0830-1000
IOWA - An Information Operations and Warfare Assessment Model
Dr. Paul E. Girard, SAIC

Cognitive Processes and Decision Making in an IW Environment
Dr. Joseph J. Hellman, TASC, Dr. Patrick McCreary, AFRL, Dr. Garrett D. Polhamus, TASC

Wednesday, 1030-1200
Reflexive Control in IW M&S
Dr. L. D. Miller, Dr. M. F. Sulcoski, NGIC

Situational Influence Assessment Module
Dr. Julie A. Rosen, Mr. Wayne L. Smith, Mr. Michael A. Maldony, Jr., SAIC

Wednesday, 1330-1500
IW MOEs - A Systems Evaluation
Mr. James E. Burke, TASC

Application of a Game Theoretic Approach to Network Survivability Improvement on DoD Communications
Captain Jeffrey A. Schavland and Dr. Yupo Chan, AFIT

Thursday, 0830-1000
Network Disruption Tool
Captain James A. Leinart, Dr. Richard F. Deckro, LTC Jack M. Kloeber, Lt Col Jack A. Jackson, AFIT

Understanding Political Instability Through Dynamic Networks
Dr. Mike Haxton and Dr. Karen T. Parsons, JWAC

Thursday, 1030-1200
Issues in OT&E for IO Evaluation
Mr. Jeffrey Ball, IDA, Colonel Terry L. Mitchell, OSD/DOT&E

Internet/Public Switched Network Interconnectivity and Vulnerabilities
Mr. James Kerr, National Communications Systems

Thursday 1330-1500
Calculating a Value for Dominant Battlespace Awareness
Maj Eric Beene, Lt Col Jack A. Jackson, Dr. Richard F. Deckro, LTC Jack M. Kloeber, AFIT

IO/IW in JWARS
Lt Col Steve Mahoney, OSD(C3I)/IO

WG 8 – INFORMATION OPERATIONS/INFORMATION WARFARE – Abstracts
Room: G-018

Tuesday, 1030 - 1200
Introduction - Lt Col Mahoney, OSD(C3I)/IO

IO Modeling and Simulation (Classified)
Mr. Steve Stigall

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Use of Fuzzy Logic in Composite Threat Assessment

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The problem of determining a unit's vulnerability to multiple threats is complicated by the uncertainty associated with threat entity data, as well as the difficulty in combining the threat levels posed by each individual threat entity into a single composite threat metric. Along with the well-known difficulty in addressing these issues, there is a growing desire to incorporate such considerations as training level, capability, and hostile intent. These particular metrics are extremely difficult to address using traditional mathematical approaches. In addition, many mathematical approaches to combining threat vulnerability fail to adequately retain the commander's intuitive experience based "feeling" for threat levels. To address these shortcomings we have developed an approach that uses fuzzy logic to address entity threat assessment, an algorithmic method to determine cumulative threat assessment, and a visualization method to assist in tactical decision making. This presentation provides a description of this approach, as well as a practical example based on a hypothetical submarine mission.

Tuesday, 1330-1500
Joint Session with WG 8 & 28 .... Room I-122

Decision Analysis and Intelligence and IO
Dr. Dennis Buede, Mr. Terry Bresnick

Value Driven MOE for IO
Captain Michael Doyle, Dr. Richard F. Deckro, Lt Col Jack A. Jackson, LTC Jack M. Kloeber, AFIT

Allocating the Threat
Mr. Peter C. Byrne, Mr. Richard E. Rosenthal, Captain Brian Widdowson

Wednesday, 0830-1000
IOWA - An Information Operations and Warfare Assessment Model

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Approved abstract not available at printing.

Cognitive Processes and Decision Making in an IW Environment

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Current and future operational requirements are contributing to increasing dependence on computer-based information and information networks. A requirement resulting from this dependence is the need for operators to be prepared to perform their mission in an uncertain information environment of the evolving battlefield. In this context, the term uncertain refers to an operational environment in which information and information systems may or may not be available or reliable, and where confidence in the fidelity of these systems may be diminished. While the demand for timely, accurate and reliable information by decision makers and warfighters is not new, the speed, dependence and potential vulnerability of these systems and data to manipulation and exploitation requires systematic consideration. An essential component to this equation is understanding the interaction between the emerging information battlefield and operators. This requirement is relevant to both offensive and defensive operations, and pertains to both to traditional and non-violent means of warfare.

This presentation will examine issues pertaining to research, training and operational methods that may improve our understanding of human factors in the IW environment, specifically with regard to cognitive factors and processes.

Wednesday, 1030-1200
Reflexive Control in IW M&S

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Reflexive control is a concept for behavior modification that makes use of a simple model of human decision behavior due to V. A. Lefebvre. This model assumes that human decisions depend on three variables (feelings (x1), thoughts (x2), and wishes (x3)) and possess a moral (positive or negative) aspect. The decision variables represent probabilities associated with the pressures to choose the positive pole. The decision function is also interpreted as a probability (that the decision agent will choose the positive pole). The agent is further assumed to possess a self-image, a function of two variables that recursively generates his behavior function (of three variables). This Theorem of Reflexion encodes human consciousness and establishes a connection with Chaos Theory (the Theorem has strong fractal aspects). Indeed, under certain circumstances the decision behavior function is chaotic. This theory is here extended in ways that have significant implications for information warfare and its modeling and simulation. A set of transformation rules that operate on any situation-dependent decision logic function (depending on a set of situation variables {y1, y2, ..., yn} together with the variable x3) and transform it into one of three generalized behavior functions is presented. These rules generate pattern functions for x1 and x2 in terms of the situation variables {yi}. The information warfare implication is that a set of control point variables (a subset of {yi}) may represent an opportunity for a controlling agent to influence the behavior of the decision agent by altering the control point variables. The most likely way of accomplishing this goal is to change the control point variables in such a way that the x2 (thought) pattern function remains fixed while the x1 (feeling) pattern function is changed so as to accomplish the desired behavior modification. The transformation rules described above provide a natural framework for this endeavor.

Situational Influence Assessment Module

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Wednesday, 1330-1500
IW MOEs - A Systems Evaluation

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Approved abstract unavailable at printing.

Application of a Game Theoretic Approach to Network Survivability Improvement on DoD Communications

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A current discussion in the information warfare community concerns defining "survivable networks." The authors contend that common metrics of network performance, such as reliability and expected throughput, are inadequate, alone, in providing a modern survivability definition, because they do not account for an adversary's focused attack on a component or components which will cause the most damage to a system. A two-person, zero-sum game was used, where a "blue" defender plays against an intelligent "red" attacker, in conjunction with two new measures of effectiveness (MOEs), a reliability-based and a flow-based "damage utility," to quantify the value of hardening network components. This multiple criteria network improvement model was applied to different representative Department of Defense communications networks. Results include the imputed monetary value of component hardening, value-free improvement plan, and corresponding enemy attack strategy.

Thursday, 0830-1000

Network Disruption Tool

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A network disruption modeling tool has been developed to assist in evaluating potential targets within a telecommunications network, prioritizing the targets accordingly, and allocating weapons to the designated targets.

Identification of target sets, which can include both links and nodes, is determined by restructuring the network and finding its node cut-sets. Value-focused thinking and decision analysis are used to quantify the "value" of each target, where value is composed of both costs and benefits to the attacker. A mathematical programming based model is then used to determine the optimal target mix.

The methodology is implemented via a user-friendly, Visual Basic-based, program. As such, this approach serves as a valuable proof of concept for use in mission planning. Its concepts can be extended to other types of networks.

Understanding Political Instability Through Dynamic Networks

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Individuals respond to many forces. Even from rational actor assumptions, the forces that affect preferences are not stationary and therefore have varying effects on preferences. The instability in individual dynamics results from the instability of the foundation of preferences -- perception. Perception leads to "herd mentality" and to panic. Efforts to conduct analysis in IO that account for the effects of operations have been limited by this chaotic tendency. Political dynamics is not *yet* well enough understood to predict the political effects of various actions.

Dynamic modeling of political phenomena suffers from two basic obstacles. First, there are few dynamic models that have been developed and tested with social and political interactions in mind. Second, the medium in which politics occurs is more difficult to observe and measure. Where does politics occur? In a *belief space*? In an *information space*? In a *policy space*? Politics can be observed all around us, but that is only because we have an intuitive idea of what to look for. Unfortunately, that intuitive idea is neither stable nor concise. These are the difficulties that await dynamic modeling of politics. With this said, it is our ultimate intention o do just that.

In this presentation, we tackle the second problem and discuss some means of tackling the first. We must come to grips with the space in which politics, and thereby political dynamics, occurs. Once this is done, we will be better able to find and validate dynamic models from physics, chemistry and biology that seem to mimic politics under various conditions..

Thursday, 1030-1200

Issues in OT&E for IO Evaluation

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Information assurance (IA) vulnerabilities of DOD systems have been inadequately addressed during system development because of a serious underappreciation of the nature and extent of the problem, a lack of tools to properly evaluate a system's vulnerabilities, and costs. Also, the computer security structure within which to respond to a highly dynamic and rapidly maturing threat is static. A number of recent

exercises have demonstrated system vulnerabilities and loss of military effectiveness caused by penetration and exploitation of hardware, software, and protective tactics, techniques, and procedures. Test and evaluation in this area to date has been unstandardized from program to program and between the Services.

This presentation proposes a methodology for an improved operational evaluation of IA vulnerabilities. The concept includes evaluations that will be accomplished early in the development cycle, with continual updates throughout the employment life of information-dependent systems. The objective is to reduce the impact of an attack, and to ensure that the warfighter is aware of the capabilities, vulnerabilities, and limitations of his information systems, and able to develop appropriate tactics to mitigate IA vulnerabilities

Systems that will require evaluation of their information vulnerabilities include:

- Weapons systems that are dependent upon external information sources or that provide information to other DOD systems (e.g., ATCCS, JSTARS)
- Computer-networked Command, Control, Communications, Computer, and Intelligence (C4I) and Automated Information Systems.

The presentation, in addition to describing the development of an operational evaluation methodology, will define work in progress on criteria or metrics, system IA requirements, and a number of other essential prerequisites for conducting meaningful evaluations that provide visibility on a system's information assurance capabilities.

It also represents an introduction to the challenges of evaluating IA vulnerabilities during system development and test. The presentation includes:

- A common IA OT&E policy for OSD and the Services.
- A roadmap to guide development of IA OT&E tools, such as metrics and a closed test facility.
- A select number of case studies employing data from OT&Es and exercises to refine the policy and roadmap components.

Internet/Public Switched Network Interconnectivity and Vulnerabilities

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This presentation reviews the process and modeling tools used to determine the vulnerabilities and the interrelationship of the Internet and the PSN. Using network modeling, critical points and dependencies can be identified in the Internet and the PSN for information warfare (IW) applications.

It is commonly believed that the Internet and the public switched networks (PSN) in the United States are two separate and distinct systems. While this is true to a certain extent, most data networks, including the Internet, rely heavily on the PSN for transport, especially for the long haul. Accessibility and availability of the Internet depend on a physical infrastructure of routers, switches, and transmission media, often using and traversing the same networks as voice traffic.

As such, the PSN plays a key role in supporting the Internet. However, the PSN is also growing in its reliance on the Internet and other data networks for signaling and network management functions. With this increasing interdependency, IW and electronic intrusion attacks are a growing threat to assured connectivity for both the Internet and the PSN. To develop an estimate on the threat posed by IW and the potential impacts of such an attack, network modeling is performed using proprietary data from interexchange carriers and Internet Service providers.

<u>*Thursday 1330-1500*</u>

Calculating a Value for Dominant Battlespace Awareness

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In times of ever-tightening military budgets, methodologies are required that can compare the contributions of various systems involved in the warfighting process. While many tools are in use that directly measure the effects of greater numbers of enhanced hardware, and even improved processes, no validated methodology exists to measure elements that contribute to Command, Control, Communications, and Computers (C4); Intelligence, Surveillance, and reconnaissance (ISR); or to analytically compare these elements with more traditional hardware.

This presentation develops a methodology for mathematically quantifying awareness in a military command and control (C2) environment. This methodology is developed using a notional scenario describing an attack on a moving target. A definition of awareness is developed and applied to this scenario. Entropy, in an information theory context, is modified to reflect not only how much is known at any level, but to show how well that information is known, producing a mathematically quantified measure of awareness. The awareness capability for various systems is calculated, and the rate of awareness loss is shown over time. Finally, an awareness curve is developed that shows the awareness of the C2 system throughout the process of attacking the ground target from the air.

IO/IW in JWARS

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Approved abstract not available at printing.

WG-9 - ELECTRONIC WARFARE & COUNTERMEASURES - Agenda

Chair: Mr. Michael F. Gauble, Lockheed Martin Corp.
Co-Chair: 1Lt. Todd C. Burwell, USAF AFIWC/SAC
Co-Chair: Mr. Michael W. Crawford, Lockheed Martin Corp.
Co-Chair: Mr. Daniel R. McGauley, JECSIM - China Lake
Co-Chair: Mr. Thomas H. Plank, Sverdrup Technology, Inc.
Advisor: Major David W. Banton, USAF AFIWC/SAC

Room: G-017

Tuesday, 1030-1200 WG Session 1
State Control Analysis of a Semi-Active Radar Seeker
Mr. Patrick Walker, 1Lt. Todd C. Burwell, USAF - AFIWC/SAC

Using Experimental Design to Evaluate the Robustness of Electronic Countermcasures
Capt. Dzung Tri Pham, USAF, 1Lt. A. David Cummings, USAF - AFIWC / SAC

Symptom Ares TEAM, MOSAIC, GTSIMS, Simulator, & Field Test Comparison
Capt. William E Palakowski, USAF, Capt. Anthony Franz, USAF- EO/IR Analysis Branch / AFIWC / SACI

Tuesday, 1330-1500 WG Session2
Electronic Warfare Mission Data Optimization, A Different Approach
Mr. Jerry D. Sowell - 53d Wing/68ECG/36ETS/EEC, USAF.

An Operational Perspective of the Electronic Combat Data Exchange (ECDATX) Data Sharing Initiative
Mr. John Crane, Mr. Thomas Plank - TEAS Group / Sverdrup Technology Inc.

Wednesday, 0830-1000 WG Session 3
Modeling and Simulation to Evaluate Electronic Warfare and Countermeasures in the JSAED Mission Area
Mr. Damian DiPappa - Coleman Research Group

Testing Advanced Distributed Simulation for use in Electronic Warfare T&E
LTC Patrick M. Cannon, USA - Joint Advanced Distributed Simulation Joint Test Force

Wednesday, 1030-1200 WG Session 4
An Integrated Method of Human Operator ECM Technique Development and Simulation
Harold Engler, Fred Wright, Dennis Folds - GTRI / Georgia Tech

Getting EC Data to the Users Via Web Technology
1Lt. Daniel Meyer, USAF, Mr. David Brown - AFIWC / DBEP, USF

Wednesday, 1330-1500 WG Session 5
The Use of Operational Modeling and Simulation in Test, Evaluation, and Wargaming: GPS on the Battlefield
Mr. Steve Friedman, - Veridian, Veda Operations and 2Lt. David Ozmen, USAF - SMC/CZE

Using Design of Experiments (DOE) to Optimize EW: A Promising Start
1Lt. James M. Higdon, USAF, 2Lt. Michael A. Martinez, USAF - 68th TSS/ETA and Mr. Gregory T. Hutto - TEAS Grp/Sverdrup Tech. Inc

Thursday, 0830-1000 WG Session 6
Employment of JDAM in a GPS Jamming Environment
Mr. Jeff Sackett - Veridian, Veda Operations

Shooting in the Dark: Validating Aircraft Self-Protection Jamming Simulations
Capt. Thomas J. Timmerman, USAF - AFSAA/SAAG, 1Lt. James M. Higdon, USAF, 2Lt. Michael A. Martinez, USAF - 68th TSS/ETA
Gregory T. Hutto - TEAS Group/Sverdrup Tech. Inc.

Thursday, 1030-1200 WG Session 7
Automatic Extraction of EWIRB Parameters from Threat Missile Simulations
Prof. P. E. Pace, Lt. G. Burton, USN - NPS, B. O'Conner, D. Kahl - Naval Research Laboratory / Tactical Electronic Warfare Div.

A Novel Independent Sensor Fusion Algorithm for Time-Space-Position Information in Captive-Carry Missile Simulation Experiments
Prof. P. E. Pace, Lt. M. D. Nash, USN - NPS, A. A. DiMattesa, A. Hosmer, Naval Research Laboratory

Room: G-017

Tuesday, 1030-1200

State Control Analysis of a Semi-Active Radar Seeker

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An anti-aircraft missile is typically placed into specific states of operation prior to launch. After launch, these states may change based on the information the missile receives from its firing unit and the environment. Electronic countermeasures (ECM) against a semi-active radar missile seeker may deliberately try to induce such state changes but a seeker does not instantaneously change from one state to another. Missile states are implemented in state control circuits, which may include analog delay timers. For example, if a seeker loses target track, it may wait some period of time before tarting a search to re-acquire the target. At issue is the length of this latency period, which varies from one nominally identical missile to another. The AFIWC has started a study of timing issues for state control circuits. The study includes use of the newest, high fidelity, missile models under Joint Modeling and Simulation System (JMASS), the MATLAB and SIMULINK software. The paper will present state diagrams of the seeker and an analysis of ECM effectiveness against variation in state control timing.

Using Experimental Design to Evaluate the Robustness of Electronic Countermcasures

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EW Systems Engineer

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Traditionally, the operational effectiveness of electronic countermeasures (ECM) techniques was determined exclusively in flight tests. Flight tests were good in providing results of high confidence but limited in terms of scope. Due to the small number of available test assets typically employed, testing provided little insight into how internal variations in the threat system impact ECM effectiveness. This problem is very relevant, as demonstrated by a flight test against two copies of the same threat system. Because of internal differences between the test assets, the performance of the ECM differed greatly. This finding heightened interest in evaluating the effectiveness of ECM against a broad spectrum of system variations. This initiative is called robustness analysis. It makes use of detailed digital models of threat systems that reproduce the effects of ECM on the given system. Models are then coupled with information and assessments of threat variations available from intelligence, exploitation, and hands-on experience gained during the modeling process.

Once we have gathered this information detailing the variation in the threat, we must decide how to use this information to analyze the resulting variation in ECM performance. In this paper, we discuss an approach to perform this portion of robustness analysis. The approach relies heavily on the statistical methodologies of experimental design. Using these techniques, we generate a set of threat system configurations representing variations of the threat system. These configurations are checked to ensure that their performance is consistent with an operational threat system. We then select a subset of these "operational" configurations for evaluating the robustness of the ECM. Our evaluation methods depend on the context of the analysis—whether we are to compare different techniques or simply evaluate a single technique. We review this analysis process by applying these steps to an example problem.

Symptom Ares TEAM, MOSAIC, GTSIMS, Simulator, & Field Test Comparison

Capt. William E. Polakowski, USAF
Chief, EO/IR Analysis Branch

Capt. Anthony Franz, *USAF*
EW Systems Engineer

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The purpose of this paper is to discuss the comparison between the Threat Engagement Analysis Model (TEAM), the Modeling System for Advanced Investigation of Countermeasures (MOSAIC), the Georgia Tech Synthetic Imaging Missiles Simulation (GTSIMS), a hardware in the loop (HITL) simulator, and field test results for the Symptom Ares seeker for an upcoming field test. The main benefit is to determine the utility, applicability, and trade-offs of these various Symptom Ares simulations in planning, and comparing to field tests and in developing tactics. The three areas this paper focuses on are: 1) Highlighting the major differences between the models and field test conditions, 2) Comparing the tools to field test data, and 3) Comparing various model implementations of the Symptom Areas. The study focuses on how well each of the simulations/field test answer the question, "How will this seeker and missile perform in the field against certain countermeasures?" Each simulation/field test makes various assumptions and has various artifacts. For the models and the simulator, much of the differences in the results come from the way they present scenes and targets to the seekers. And, in the case of TEAM, the relevance of

the reduced fidelity implementation is an issue. While for the field test, the missiles are in a very constrained environment, with no real closure rates or flyout. The first part of this effort will attempt to explain and trade-off these assumptions to form a basis for the comparison of the results. The second focus of this paper is to compare the actual results from the different methods and to draw some conclusions from the results. And finally, the paper will try to open a window into the actual differences in the seeker models used in TEAM, MOSAIC, and GTSIMS.

Tuesday, 1330-1500

Electronic Warfare Mission Data Optimization, A Different Approach

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Defines the differences between Electronic Warfare (EW) jamming techniques and EW Mission Data (MD) from an operational perspective. Discusses an approach to develop robust MD by the application of software tools to analyze internal waveforms created by various MD parametric sets. The objective is to develop a procedure to predict optimum MD sets when models and instrumented radar systems are not available.

Reviews the results of a recent multiple service application of this approach to a system "hardened" against conventional jamming waveforms.

An Operational Perspective of the Electronic Combat Data Exchange (ECDATX) Data Sharing Initiative

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This presentation and technical report describe the implementation of the Electronic Combat Data Exchange (ECDATX) data sharing initiative from an operational perspective. The ECDATX architecture of distributed data servers using Web technologies is providing both local and remote users near-real-time access to Electronic Attack (EA) engineering and test data collected during Performance Characterization Analyses (PCAs) conducted on the Eglin AFB, FL ranges. The ECDATX architecture uses existing Secret Internet Protocol Router Network (SIPRNET) and Unclassified but Sensitive Internet Protocol Router Network (NIPRNET) with Network Encryption Systems (NES) communications links.

The Web server architecture uses hypertext links to all engineering and test data, as well as archived CD-ROMs available through the on-line CD-ROM Juke Box. The ECDATX Concept of Operations provides guidance for operation, maintenance and continued development of this data sharing initiative. Work is under way by AFIWC/DBEP to integrate the ECDATX architecture into the AF/EWIO Jammer Effectiveness and Techniques Web.

The implementation of ECDATX was presented at the 65th MORS in a technical paper describing the development and evaluation of the data sharing concept and architecture. Since the successful evaluation of ECDATX in supporting the April 1997 MOBCAP EAST PCA, ECDATX has provided continuous data sharing support for PCAs performed at Eglin AFB during the last year and has continued to expand the data sharing capabilities and the user organizations supported.

Wednesday, 0830-1000 WG-9 Session 3

Modeling and Simulation to Evaluate Electronic Warfare and Countermeasures in the JSAED Mission Area

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Modeling and simulation (M&S) is an inexpensive means of evaluating the effectiveness of innovative tactics, techniques and technologies (TTTs) against sophisticated enemy air defense systems. The Joint Suppression of Enemy Air Defenses Mission Area Architecture (JSEAD MAA) study, chartered by DEPSECDEF, used M&S to provide the technical underpinnings in evaluating existing and alternate means of conducting JSEAD operations, across the mission area, in the 2006 timeframe and beyond.

The JSEAD MAA study pooled the resources of each service to build data sets and battlefield concepts for the M&S effort. The Extended Air Defense Simulation (EADSIM) was used for mission level M&S with added inputs from task specific models such as the Enhanced Surface-To-Air Missile Simulation (ESAMS), Radar-Directed Gun Simulation (RADGUNS), Integrated Many-On-Many Simulation (IMOM) and in-house built data-to-simulation translation tools.

Specific to electronic warfare and countermeasures, the JSEAD study evaluated existing and planned TTTs as well as new and innovative concepts. ICAP III jamming, defensive electronic countermeasures (DECM), decoys and anti-radiation missiles are examples of current or planned TTTs . Innovative concepts consist of advanced anti-radiation missiles, using unmanned systems as jammers and non-traditional C4ISR connectivity cueing reactive SEAD. Threat innovations were also explored; sophisticated emission control, decoy emitters, dual-mode seekers and mobility are challenges to the future JSEAD planner and warfighter.

This presentation will focus on the current, new and innovative electronic warfare and countermeasures methods and technologies (friendly and threat) modeled within the JSEAD study. M&S techniques and tools used will also be emphasized.

Testing Advanced Distributed Simulation for use in Electronic Warfare T&E

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The Joint Advanced Distributed Simulation (JADS) Joint Test Force is developing a specific approach to test and evaluate the utility of Advanced Distributed Simulation (ADS) to support Electronic Warfare system tests. The presentation outlines the details of the test methodology, the ADS test architecture for testing an EW system, and the experience gained in use of DMSO's High Level Architecture (HLA).

The emphasis of this test is not on evaluating the EW system's performance in use as a test article; rather, the emphasis is on the performance of the ADS components and their relative contribution to EW testing. The ADS-oriented test approach will evaluate distributed test control and analysis, network performance, relationships between data latencies, ADS induced data anomalies, and use of the HLA methodology and the Run Time Infrastucture (RTI). A series of tests have been designed which will support comparison of data and results from open air range testing and two ADS-based tests. There are significant technical challenges to fully implementing ADS in EW T&E and the achievable performance that can be obtained from ADS (and the RTI) to support the EW test process must be determined.

The EW test design described in this presentation contains the critical ADS-related test activities for determining the extent to which ADS may be used in EW T&E as well as JADS' implementation and use of HLA methodology. This paper provides unique insight into the work-in-process to establish an ADS test, critical planning and technical issues related to ADS use for EW T&E, and insights gained from ongoing use of the High Level Architecture.

Wednesday, 1030-1200 WG-9 Session #4

An Integrated Method of Human Operator ECM Technique Development and Simulation

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Any defense investment should be based on the anticipated contribution to military utility. The process of defining military deficiencies translates requirements progressively downward until the technology opportunities are revealed. Likewise, the value of a selected technology, or technique is translated upward to reveal its military utility. This translation process, in both directions, is often performed using simulation, as it is cost-prohibitive to implement the realistic conditions of war for test purposes. To assess military utility and to develop and test new systems, various levels of simulation are required.

Detailed, low-level simulations (e.g., dynamic or EC capable) are often the most difficult to develop and validate since they represent the behavior of actual physical devices. Even more difficult to represent accurately is the behavior of the human operator; but yet, in many threat weapon systems, the operator is the most effective ECCM feature in the system.

Over a number of years, GTRI has devised a process of developing ECM techniques, evaluating operator responses, and modeling the human operator behavior. This three-part process begins with the development or selection of candidate ECM techniques and the subsequent collection of basic effectiveness data using a real-time laboratory radar/ECM simulator to test candidate ECM techniques against human operators. (This phase is used to refine or eliminate candidate ECM techniques early in the process.) In the next phase of the process, experiments are designed and executed to collect statistically significant data to describe the operator's performance and technique effectiveness. Finally, OAR tests are used to enhance and validate the data collected in the previous steps. After each step of this process, a model of the human operator is developed using the "model-test-model" approach.

Developing and evaluating ECM techniques to defeat the human operator requires experimentation with real operators using real displays and controls on a real-time version of the threat system. Because of the required number of test trials for statistical validity, ECM parameter sensitivity, and learning effects, this experimentation is best accomplished in a laboratory setting.

Vital data is also obtained from operators in the HITL and OAR facilities. Interview surveys of these people are used to obtain additional information about the detectability of cues in the ECM technique and operator techniques for avoiding ECM effects.

Once an effective technique is determined in the laboratory, it is possible to develop a simulation of the operator's response to the technique. The operator simulation is based on the experimental data, and validated against it. Once available, this operator simulation can be integrated with the overall simulation of the threat weapon system, and the successive layers of assessment can begin to reflect the military worth of the technique.

Human responses are ECM technique dependent. Only through experimentation can effective techniques be developed. Similarly, it is only through experimentation that a valid operator model can be developed. Since the human operator is a critical part of a weapon system, only with a valid operator model as part of the overall weapon system simulation, can the military worth of an ECM technique be accurately evaluated.

This paper provides an overview of the process developed by the Georgia Tech Research Institute to design ECM techniques to defeat human operators, and the simulation architecture which captures this behavior for use in military worth assessments. This process is described within the context of the EW Development and Test Process and illustrated with real-world examples.

Getting EC Data to the Users Via Web Technology

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This demonstration will show how parametric information on US owned and operated electromagnetic systems can be accessed over Intelink-SCI using a web browser interface developed at the AFIWC. The demonstration will provide an overall view of the data available in the United States Electromagnetic Systems (USELMS) datakase, show how that data can be accessed, and describe the type of gueries built into the interface. The demonstration will include a description of the current status of the project and desired future capabilities. A question and answer period will be provided at the end of the demonstration to gauge customer interest and to get feedback.

Wednesday, 1330-1500 WG-9 Session 5

The Use of Operational Modeling and Simulation in Test, Evaluation, and Wargaming: GPS on the Battlefield

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GPS provides the Warfighter with precise position, velocity and timing information on the battlefield. This information can give the U.S. and Allied Forces a decisive advantage in navigation, communications, force enhancement, and precision weapons employment. Recently, studies have investigated the effects of a challenged EW environment on the operational use of GPS-aided weapon systems. This paper addresses the use of modeling and simulation to assess the impacts of this environment on the battlefield and how these same methods can be used to enhance operational and developmental test and evaluation, as well as to support exercises and wargames. An analytic approach for constructive modeling will be outlined, along with potential applications for virtual and live simulations.

Using Design of Experiments (DOE) to Optimize EW: A Promising Start

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Principal Engineer

The 68 Electronic Combat Group improves EW effectiveness through modeling, simulation, and flight test analysis. Until recently, resource constraints severely limited the scope of our studies. Multiple scenarios, different years, terrain, and threat layouts, are one aspect of the problem. Also, different platforms and techniques add complexity, while a range of warfare models, such as digital, ground mount, and flight tests present more issues. The Electronic Warfare Center of Excellence for Analysis (EWCEA) has recently begun to employ Design of Experiments (DOE) to address the full Electronic Warfare parameter space. We hope to propel these techniques in the EW/T&E realm.

DOE is a branch of applied statistics that began in 1920. When effectively practiced, DOE allows for more efficient testing, yields more process insight, and produces more conclusive results than standard scientific testing.

Thus far, EWCEA has applied DOE to three studies: a Radio Frequency Countermeasures study, an ongoing F-15 Tactical Electronic Warfare System study, and a B-1B Electronic Attack formation study, each with assuring results. In the first study, we needed to validate requirements for an ORD using a scenario-level simulation, THUNDER. Using DOE to find the critical settings for the RiLs, we realized a 20% reduction in simulation runs. In the second study, where the objective is to correlate the simulation with flight test results, we have already seen more than 50% savings in test sorties. Finally, in the B-1 test support, we were able to examine nine variables' significance (over 512 combinations) with only 64 test conditions.

Thursday, 0830-1000 WG-9 Session 6

Employment of JDAM in a GPS Jamming Environment

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The purpose of this study was to provide an analytically-based CONOPS that minimizes the impact of GPS jamming on the Joint Direct Attack Munition (JDAM) weapon system. Because JDAM's effectiveness is highly dependent on the accuracy of the hand-off information from the aircraft, this study first determined the impact of GPS jamming on the delivery aircraft's navigation system and then determined the resultant impact this navigation error has on JDAM's circular error probable (CEP) at the target. This study then examined those tactics (non-material solution countermeasures) that could be used by the aircrew in an integrated manner to reduce the impact of GPS jamming on the aircraft and JDAM. Ultimately, the overall goal of this CONOPS was to determine how operationally sound tactics could be used to provide JDAM with the smallest CEP at a target in a GPS jamming environment.

Shooting in the Dark: Validating Aircraft Self-Protection Jamming Simulations

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Self-protection jamming by aircraft against surface-to-air missiles (SAMs) presents a particularly difficult problem to the tester and the analyst, complicating both the test & evaluation and the requirements analysis of such electronic warfare systems. Because the US Air Force does not shoot live missiles at live pilots, operational flight testing of self-protection jamming involves detailed hardware and constructive simulation to evaluate the effectiveness of the jamming system. Our best assessment of jammer performance is itself based on models, making validation of simulations used in the test process and for other analyses problematic. The resulting implications for electronic warfare analysis & testing using SAM simulations are disquieting, motivating investigation.

This paper describes recent work by testers & analysts to confront this problem, using F-15 TEWS flight testing and the ESAMS model. Various statistical methods were examined for comparing the flight test & ESAMS results, including analysis of variance, non-parametric statistics, and time-series analysis. Supplemental flight testing, planned using Design of Experiments techniques, were flown specifically for validation data collection. Insights of the comparison effort will be fed back into the models' refinement and V&V cycles, for improvement of both the range test process and ESAMS. Additionally, the documented flight test results will be archived for later SAM validation efforts.

Thursday, 1030-1200 WG-9 Session 7

Automatic Extraction of EWIRB Parameters from Threat Missile Simulations

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Anti-ship cruise missiles (ASCMs) continue to be a poignant threat to the surface combatants of the U. S. Navy. OPNAV 913 directs the Effectiveness of Navy Electronic Warfare Systems (ENEWS) program to develop hardware-in-the-loop (HIL) simulators to support the research, development, test and evaluation of electronic warfare (EW) tactics, techniques, and systems for critical threats of interest. The HIL missile simulators utilize captured or production representative hardware interfaced with high-performance computer modeling. These simulators have one or more characteristics which when detected by self-protection systems, provide the appearance of an actual threat missile system with a prescribed degree of authenticity. To insure that the ASCM simulator accurately represents the threat missile, OPNAV 913 has recently established the Navy unique ASCM Simulator Validation Working Group. One part of the validation process is to run the ASCM simulator through a battery of anechoic chamber characterization tests to determine the simulator's performance. The ASCM simulator's Electronic Warfare Integrated Reprogrammable Database (EWIRDB) parameters can easily be extracted from the characterization results using computer algorithms that automatically analyze the data. Comparing the corresponding measured parameters with the EWIRDB intelligence entries then provides one technique for documenting the performance of the ASCM simulator.

This paper describes a novel set of algorithms that allow a simulator's EWIRDB parameters to be readily extracted from the characterization data and be automatically compared with the EWIRDB intelligence values. Advantages include a suitable user interface and a modular architecture allowing for program maintenance and straightforward implementation of newly developed algorithms. This method eliminates possible errors incurred while manually extracting the parameters. The performance of a new threat simulator is numerically evaluated as a function of the characterization test results using these algorithms. Additionally, the correlation of the threat simulator output data with available intelligence data is quantified.

A Novel Independent Sensor Fusion Algorithm for Time-Space-Position Information in Captive-Carry Missile Simulation Experiments

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Captive-carry electronic warfare experiments are performed using hardware-in-the-loop (HIL) missile simulators in order to determine the effectiveness of the targeted platform's electronic attack (EA) self-protection system. To determine the EA effectiveness, these experiments require that the position of the captive-carry aircraft and other moving objects on the test range (e.g., chaff) be known precisely as a function of time. Distributed Sensor, Time-Space-Position Information systems have been used to provide this information and typically consist of two or more measurement sensors located at some distance from each other with each sensor making a measurement of the target's angle and range. These systems are considerably complex since they involve multiple hardware installations, complex mathematical computations for extraction of coordinate information, synchronization of multiple sensor measurements and independent calibration of several different measurement stations. Consequently, the accuracy of the resolved target positions can be severely degraded.

This paper presents an independent sensor fusion algorithm that accurately displays in geodetic coordinates, a complete pictorial presentation of a field test experiment using only the onboard sensors in the captive-carry aircraft. By successfully synchronizing and integrating data from the Inertial Navigation System (INS), the Global Positioning System (GPS), and the targeting information from several distributed HIL missile simulators, accurate displays of the range results are provided for easy interpretation and analysis. The architecture presented also provides both manual and automatic tagging routines to analyze and evaluate specific points of interest during a particular field test scenario (e.g., missile transfers track to decoy). Actual captive-carry field test results using anti-ship cruise missile HIL simulators are presented in order to demonstrate the advantages of our approach.

Electronic Warfare Visualization and Simulation

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Approve abstract unavailable at printing.

A New Approach to Quantifying the Payoff from ECM Robustness Analyses

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Approve abstract unavailable at printing.

<u>Wednesday, 1330-1500</u>

The Partnership Process for Electronic Warfare Acquisition

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Approve abstract unavailable at printing.

Survivability Network Design for Armored Vehicles

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Approve abstract unavailable at printing.

<u>Wednesday, 1530-1700</u>

(The following two papers treat different aspects of a common project at AFIWC)

Evaluating the Robustness of ECM Techniques

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Traditionally, the operational effectiveness of Electronic Countermeasures (ECM) techniques was determined exclusively in flight tests. Flight tests were good in providing results of high confidence but limited in terms of scope. Due to the small number of available test assets typically employed, testing provided little insight into the impact of variations in the threat performance on measurement of ECM effectiveness.

Recently, a new focus has been placed in the Air Force on evaluating the effectiveness of ECM against a broad spectrum of system variations. This initiative is called Robustness Analysis and makes use of modeling and simulation (M&S) in support of traditional testing. Key to the analysis are the detailed digital models of threat systems which reproduce the effects of ECM on the given system. Models are then coupled with information and assessments of threat variations available from intelligence, exploitation, and hands-on experience gained during the modeling process. A capability is thus realized to create in simulation a realistic cross-section of the threat system population. This sample provides the basis for assessment of ECM effectiveness—the essence of Robustness Analysis. We present results of a proof of concept demonstration performed at the Air Force Information Warfare Center (AFIWC). Simulations are generated and statistically analyzed to evaluate the robustness of a given ECM technique.

Threat System Configuration Changes on AM Modulation Effectiveness

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Approve abstract unavailable at printing.

<u>*Thursday, 0830-1000*</u>

Modeling and Simulation in Navigation System Test and Evaluation

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Emitter Location and Display Simulation (ELADS)

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Approve abstract unavailable at printing.

WG 10 – UNMANNED SYSTEMS – Agenda

Chair: Ms. Mary L. Ray, US Army TRADOC Analysis Center
Cochair: Mr. Thomas Haduch, US Army Research Laboratory

Room: G-117

Tuesday, 1030 - 1200
Test and Evaluation of the Soldier-Machine Interface Between the Apache Longbow and an Unmanned Aerial Vehicle
Ms. Michelle Pouliot, The Boeing Corporation

Human Factors in Unmanned Ground Vehicles
Mr. Dave Scribner, Army Research Laboratory

Tactical Control System: A Common Interoperable Ground Control Station for Tactical Unmanned Aerial Vehicles
LCDR Greg Silvernagel, PEO(CU) Tactical Control System

Tuesday, 1330-1500
COMPOSITE GROUP B SESSION... Room G-109

Wednesday, 0830-1000
Unmanned Aerial Vehicles (UAVs) as Communications Platforms
Ms. Virginia Wiggins, Joint C4ISR Decision Support Center

Intelligence, Surveillance, Reconnaissance (ISR) Investment Study
MAJ James Barnes, US Air Force Studies and Analysis Agency and Mr. Kurt Willstater, MRJ Technical Solutions

Mission Analysis of Space Operations Vehicle (SOV)
Mr. Eric Zust, The Boeing Corporation

Wednesday, 1030 - 1200
US Air Force Unmanned Aerial Vehicle Battle Lab Projects
MAJ Steve Bishop, US Air Force UAV Battle Lab

Force XXI Unmanned Aerial Vehicles and the Army Advance Warfighting Experiment
Mr. Sonny Haskins, TASC

AAN Requirements for Unmanned Aerial Vehicles
COL James Armstrong, Jr., MAJ Greg Brouillet, and MAJ Jeffrey Joles, US Military Academy

Wednesday, 1330-1500
Unmanned Ground Vehicles, Demo III
Mr. Tom Haug, US Army Research Laboratory

Tactical Unmanned Vehicle (TUV) and the TUV User Appraisal
Ms. Susie Young, Unmanned Ground Vehicles/Systems Joint Project Office

Modeling and Ground Vehicle Mobility
Mr. Gary Haas, US Army Research Laboratory

Thursday, 0830-1000
Unmanned Aerial Vehicle Weather Vulnerability Analysis
CPT Philip Buford, US Army TRADOC Analysis Center-Ft. Leavenworth

Unmanned Aerial Vehicle Vulnerability Assessment
Mr. Sonny Haskins, The Analytical Sciences Corporation

ADS and Analysis- Lessons from STOW 97
COL Gary Coe (Ret), Institute for Defense Analysis

Thursday, 1030-1200
Engineering Unmanned Aerial Vehicle Systems Using Executable Architecture Technology
Mr. Jeff Lankford, Northrup Grumman Corporation

Effects of Simulating Tactical Unmanned Systems
Mr. Kevin Young, US Army TRADOC Analysis Center-White Sands Missile Range

Naval Postgraduate School UAV Program; A Broad-Based Capability
Dr. David Netzer, Naval Postgraduate School

Thursday, 1330-1500
Center for Autonomous Underwater Vehicle Research Projects
Dr. Tony Healey, Naval Postgraduate School

WG 10 – UNMANNED SYSTEMS – Abstracts
Room: G-117

Tuesday, 1030 - 1200
Test and Evaluation of the Soldier-Machine Interface Between the Apache Longbow and an Unmanned Aerial Vehicle
Ms. Michelle Pouliot
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The Boeing Company is studying a concept that involves teaming the Apache Longbow™ with unmanned air vehicles. Teaming a manned system, such as the Apache attack helicopter, with unmanned air vehicles has the potential to substantially benefit attack and reconnaissance helicopter operations. Potential benefits include increased lethality, survivability, and efficiency for both the aircraft and UAV. The US Army/Boeing AH-64D Apache Longbow has the most advanced integrated control and display suite of any helicopter in production today. This advanced design allows the pilot and co-pilot gunner to employ the advanced equipment incorporated in the aircraft without creating task overload. During the study, Boeing crewstation design engineers have developed a preliminary soldier-machine interface that allows the aircrew to perform manned-unmanned teaming operational tasks. In the Fall of 1997, Boeing conducted a study to assess the soldier-machine interface. The soldier-machine interface assessment covered four crucial areas: presentation of data; functionality of design; utility of design; and crew workload levels during manned-unmanned teaming operations. Initial results of the soldier-machine assessment were favorable both to the design and to the manned-unmanned teaming concept. The two week study took place in the Longbow Engineering Development Simulator (EDS) where teaming the Apache Longbow with a UAV in a reconnaissance scenario was simulated. This paper will present an overview of the virtual simulation to include the EDS configuration and capabilities, scenario description, new UAV-unique controls and displays suite features, test methodology, and study results.

Tactical Unmanned System - Human Factors Findings
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Approved abstract unavailable at printing.

Tactical Control System: A Common Interoperable Ground Control Station for Tactical Unmanned Aerial Vehicles
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The Tactical Control System (TCS) is a joint solution which will provide a common interoperable ground control station (GCS) for all tactical unmanned aerial vehicles (UAV). It will have the capability to control legacy system air vehicles (AV) and their payloads such as Predator UAV and Pioneer UAV. TCS will be the GCS for the Outrider Tactical UAV and will be the GCS for all future Tactical UAVs such as the Vertical Takeoff and Landing (VTOL) UAV. Current UAV systems are stove piped in that their AV and GCS are proprietary and not interoperable with legacy UAV systems, nor do they provide a path to a future interoperable system. In addition, the payload information provided by these systems is usually limited in its distribution to only the local commander. TCS provides connectivity to a host of Command, Control, Communications, Computer and Intelligence (C4I) systems. TCS eliminates the need for each stove pipe system to independently develop the C4I interfaces and certifications. It also significantly reduces proprietary hardware, software and information providing increased flexibility and a system more capable of affordable growth to future UAVs and payloads. TCS provides the capability for a more affordable

user training process through a standard human computer interface (HCI) regardless of the type of UAV being controlled. Also, most of the hardware is either Government Off-the-Shelf (GOTS) or Commercial Off-the Shelf (COTS) which reduces the additional maintenance, training and supportability requirements to only those TCS unique items. Although there are no TCS prototype systems available for testing, some preliminary analysis of information from demonstrations and advanced warfighter experiments has been done. This analysis indicates TCS provides a significant increase in the amount and variety of near real time intelligence information available to the local tactical commander. Through the C4I connectivity provided by TCS, this information is also available at higher command levels. With multiple TCSs throughout the battle field, the theater commanders will be provided with a range and quantity of near real time intelligence unlike anything previously available. By integrating this information into the overall battlefield picture, the TCS UAV provided information will become an important new tool for battlefield management. In addition, any new analysis completed prior to the MORS symposium would also be include in the presentation.

Tuesday, 1330-1500

COMPOSITE GROUP B SESSION .... Room G-109

Wednesday, 0830-1000

Unmanned Aerial Vehicles (UAVs) as Communications Platforms

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This presentation provides an overview of analysis conducted for the Senior Steering Group (SSG) consisting of ASD (C3I) , USD (A&T) and the Vice Chairman of the Joint-Chiefs-of-Staff. The question posed by the SSG was; "What are the cost and benefits of using unmanned aerial vehicles (UAVs) as theater and tactical communication links in place of or in addition to satellite communication systems?" To explore the technical feasibility, operational effectiveness, and cost benefits for using UAVs in a communications role the analyses focused on three separate cases. The environment developed for the cases was a South West Asian scenario, with a six month duration, evaluating Strategic, Theater, and Tactical operations.

Intelligence, Surveillance, Reconnaissance (ISR) Investment Study

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The Air Force Studies and Analyses Agency (AFSAA) conducted this study for AF/XOC and the Defense Airborne Reconnaissance Office (DARO). The study assessed the warfighting impact of investments in selected ISR systems and investments in strike weapons capability. AFSAA investigated the impact of alternative strike mixes using High Leverage Munitions (HLM) concepts such as the Low Cost Autonomous Attack System (LOCASS) and small smart bomb. AFSAA used a unique methodology to conduct this study. It linked two optimization tools to address the end to end effects of ISR and strike. The first optimization program address ISR aspects of the study. The Sensor Platform Allocator Model Analysis Tool (SPAM/AT) allocated the specified ISR force mix to collection requirements. Based on this allocation, SPAM/AT determined theater coverage probabilities by target type, location (distance band) and phase of the conflict. These theater target coverage probabilities were then used in the Combat Forces Assessment Model (CFAM) in the form of degradation to expected kills per sortie (eks) values. CFAM is a linear programming model that uses air campaign goals, strike platforms, munitions, and CONOPS to optimize air campaign outcomes.

Mission Analysis of Space Operations Vehicle (SOV)

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This presentation details The Boeing Company approach to developing the USAF Space Operations Vehicle (SOV). The SOV is an advanced reusable space vehicle that will provide the military commander with flexible, on-demand space sorties to fulfill a variety of mission needs. The SOV will provide more affordable space lift than today's systems by virtue of its reusability – the launch vehicle will be recovered, refurbished, refueled and launched again, much like today's aircraft. These "aircraft like" operations result in space sorties that can be scheduled and flown as a result of the immediate needs of the modern battlefield. SOVs will be based within the Untied States, eliminated

the need for foreign deployments and difficult logistic support systems. SOV mission requirements were developed through an operations research evaluation that addressed future military needs. Mission needs were derived through structured analysis of mission areas, alternative system shortfalls, and mission importance. The mission analysis addressed SOV system needs, potential applications, concept of operation, and resulting operational and performance requirements. Boeing has developed a family of SOV concepts derived from the flight proven Delta Clipper Experimental (DC-X/DC-XA) programs, to meet these mission requirements. The mission analysis addresses the use of various types of SOVs to satisfy future military requirements.

Wednesday, 1030 - 1200

US Air Force Unmanned Aerial Vehicle Battle Lab Projects

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Approved abstract not available at printing.

Force XXI Unmanned Aerial Vehicles and the Army Advance Warfighting Experiment

TRADOC System Manager-UAV

Approved abstract not available at printing.

AAN Requirements for Unmanned Aerial Vehicles

COL James Armstrong, Jr.; MAJ Gregory Brouillette; MAJ Jeffery Joles
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The Future Battle Directorate at the US Training and Doctrine Command and the TRADOC Analysis Center-Ft. Leavenworth have asked the Department of Systems Engineering at the USMA to refine and improve the 21st century Army After Next vision for the UAV force structure. A USMA faculty and cadet operations analysis team is defining the AAN UAV requirements which must be met at the Battle Force, Battle Unit, and Battle Element levels. A Cadet design team is applying the Systems Engineering Design Process methodology to understand the operational concepts of 21st century warfare and UAV employment. The cornerstone is the understanding the client's UAV requirements, the interrelationships, and the development of engineering characteristics. This understanding will allow the design team to address UAV force structure requirements. Modeling and evaluation of the UAV requirements will be completed in April 1998. The force structure analysis will be addressed separately.

Wednesday, 1330-1500

Unmanned Ground Vehicles, Demo III

Mr. Tom Haug
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Approved abstract not available at printing.

Tactical Unmanned Vehicle (TUV) and the TUV User Appraisal

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Approved abstract not available at printing.

Modeling and Ground Vehicle Mobility

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Approved abstract not available at printing.

Thursday, 0830-1000

Unmanned Aerial Vehicle Weather Vulnerability Analysis

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This analysis, conducted by TRADOC's Study and Analysis Center (TRAC-SAC), assessed the effects of climatic conditions on the Family of Unmanned Aerial Vehicles' mission accomplishment. It focused on the question "how will weather conditions impact UAV mission accomplishment?" The study used various sources to build the seasonal weather profile for Central Europe, Southwest Asia, and Northeast Asia. Weather affects UAV's ability to accomplish its designed mission in two ways: the ability of the air vehicle to fly and the ability of the sensors to see their targets. The first step in the analysis was to identify critical weather and climatic conditions effecting the air vehicle and sensors performance for three regions of the world. Next, weather profiles for the three regions were developed and the frequency of occurrence for the degrading conditions was assessed. Finally, weather profiles were combined with UAV air vehicle and sensor capabilities to estimate the impact of weather on UAV operations. The three regions of the world included in this assessment are Central Europe, Southwest Asia, and Northeast Asia. The assessment focused on weather effects on UAV sensors and air vehicles. The frequency of cloud ceilings. along with the frequency of icing, wind, and fog conditions were examined for the three regions.

Unmanned Aerial Vehicle Vulnerability Assessment

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Approved abstract not available at printing.

ADS and Analysis - Lessons from STOW 97

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STOW 97 is an Advanced Concepts Technology Demonstration for demonstrating the effectiveness, efficiency, and potential of the Advanced Distributed Simulation (ADS) in facilitating the training and mission rehearsal objectives of the commanders and staffs of the Joint Task Force and its components. However, the STOW technologies have implications in areas beyond training that include analysis.. On balance, the requirements for analysis are changing as the result of a new global environment and technological capabilities. This presentation uses lessons from STOW 97 to examine how ADS can and should support analysis in the future, given emerging analytical challenges that require new analytic methods and tools. Some particular analyses where ADS can have a substantial impact are identified - particularly information processes. STOW 97 was interfaced with several real world C4I systems including GCCS, MCS-P, CTAPS, AFATDS, JSTARS, and E-OPS. These interfaces permitted real world processes to interact with simulated events realistically. STOW 97 included sophisticated ways for communication between real world activities and simulated events that allows new ways of analyzing processes such as intelligence, battle damage assessment, resource allocation, planning, and logistics. For example, an air tasking order was implemented effectively in the simulation. Simulated aircraft commanders reported on mission completions. Intelligence agents, desiring more specific information about the damage could task sensors to look more closely. These included electronic and optical surveillance. Also, terrain analysis was conducted. This discussion is balanced with a consideration of the challenges of ADS. The presentation then considers the incorporation of ADS within a broader research plan highlighting some of the special properties of ADS that make it useful for analysis and some new analysis techniques that should be considered, particularly in experimental design. Also, some technological challenges are identified to improve ADS for analysis. The presentation advocates the development of new approaches to data analysis and a greater dependence on visualization vice statistical analysis.

Thursday, 1030-1200

Engineering Unmanned Aerial Vehicle Systems Using Executable Architecture Technology

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Effects of Simulating Tactical Unmanned Systems

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The purpose of this project is to investigate a means of modeling ground Tactical Unmanned Systems (TUS) at night in a Deliberate Attack European scenario to provide assessments of the TUS reconnaissance, surveillance, and target acquisition (RSTA) capabilities. One goal is to integrate the RSTA functions to provide a common intelligent picture for the maneuver elements. That will enhance combat system platforms with more timely and accurate targets; provide Situational Awareness (SA) of the threat systems; and, in hazardous RSTA situations, allow the absence of human presence. To accomplish this task a new scenario was developed with improved decision logic within the CASTFOREM combat simulation model to simulate the Tactical Internet, complex maneuver algorithms, communication networks that include voice transmission duration times, and command and control methodologies based on a threat intelligent picture. The new high resolution scenario (HRS 64) developed at TRAC, depicts night reconnaissance, counter-recon operations, dismounted infantry fight, and a early dawn TF Deliberate Attack. The representation of Red (enemy) includes improved logic to simulate a more realistic crew coordination in Armored Fighting Vehicles (AFVs), command and control based on a intelligent picture from voice communication, complex maneuver algorithms using inner visibility lines for concealment and engagement positions, and ambush tactics based on the intelligence picture.

Naval Postgraduate School UAV Program; A Broad-Based Capability

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Approved abstract not available at printing.

Thursday, 1330-1500

Center for Autonomous Underwater Vehicle Research

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Alternates

Unmanned Underwater Vehicles Initiative

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Approved abstract not available at printing.

Modeling and Analysis of Unmanned Ground Systems at the MMBL

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WG 11 – Military Environmental Factors

Chair: Dr. Theodore Bennett, Jr. Naval Oceanographic Office
Cochair: Philip Doiron, Applied Research Associates, Inc.
Cochair: John Elrick, Air Force Operational Test and Evaluation Center
Cochair: Lisa Tubridy, Naval Coastal Systems Station
Advisor: Eleanor Schroeder, Naval Oceanographic Office

Room: R-240

Tuesday, 1030-1200: WEATHER IN MODELING & SIMULATION AND WARGAMES
Inserting Weather into Simulation-Based Acquisition
LtCol John Lanicci, USAF, 88th Weather Squadron

The Weather Scenario Generator
Mr. Gary McWilliams, Executive Agent for Air and Space Natural Environment

Weather Wargames
LtCol Frank Zawada, USAF, Air Force Research Laboratory

Environment Modeling in War Games
Dr. Steven Kovel, Army Research Laboratory

Tuesday, 1330-1500
COMPOSITE GROUP B SESSION... Room G-109

Wednesday, 0830-1000: ENVIRONMENTAL APPLICATIONS OF SPACE SYSTEMS, ESPECIALLY COMMERCIAL IMAGERY SYSTEMS
Joint Session with WG 5 & 6.. Room G-102

Naval Oceanographic Applications of Space Systems
Mr. James Rigney, Naval Oceanographic Office

An Overview of Orbital Imaging Corporation's Satellite Imaging Services
Mr. Joe Dodd, Orbimage, Inc.

EarthWatch, Incorporated
Mr. Jeffrey Kerridge, EarthWatch, Inc.

Commercial Remote Sensing Can Change the Environment of Military Forces
Ms Tish Williams, Space Imaging Eosat, Inc.

Wednesday, 1030-1200: ASSESSMENT OF SATELLITE SYSTEMS
Joint Session with WG 5 & 11.. Room G-102

Quantifying the Military Value of Weather Information in an Air Campaign
CAPT David Lyle, USAF, AFMC/DR - OAS

Warfighting Assessment of NPOESS
LtCol Frank Zawada, USAF, Air Force Research Laboratory

Surveillance Satellite Constellation Analysis
Mr. Luther Briggs, Mr. Ron Roehrich, COL Sal Alfano, USAF, and Dr. David Finkelman
NORAD and USSPACECOM

Simulation of Communications, Command, and Control for Warning and Defense
Dr. Roy Mitchell, Dr. David Finkleman, LTC John Weatherford, USA
NORAD and USSPACECOM

Wednesday, 1330-1500: ENVIRONMENT & SPECIAL OPERATIONS

Joint Session with WG 11 & 16... Room G-102

SOF-MEM: A Frontal Assault on the "Critical Meteorological and Oceanographic Thresholds for SOF Operations"
Mr. Anthony Cowden, Sonalysts, Inc.

An Intelligent Analysis Methodology for Military Reconnaissance and Surveillance Misions
Mr. Phillip Doiron, Applied Research Associates, Inc.

METOC Support to Military Operations Research: Special Operations Forces
Mr. David Pitcher, Naval Oceanographic Office

Thursday, 0830-1000: ENVIRONMENT & LAND WARFARE
Joint with Working Group 12, Land & Expeditionary Warfare

Representing Ground Vehicle Mobility in Virtual Environments with Relevance to Materiel Development and Tactical Trainers
Dr. Niki Deliman,, U.S. Army Engineers Waterways Experiment Station

The JCATS Terrain Model and Its Effects on Conflict Simulation
Mr. Gary Friedman, Lawrence Livermore National Laboratory

The JCATS Lighting Model and Its Impact on Simulated Conflict
Mr. Thomas Kelleher, Lawrence Livermore National Laboratory

Transportation Infrastructure Assessment
Dr. David Horner, Dr. William Willoughby & Dr. Niki Deliman, U.S. Army Engineers Waterways Experiment Station

Thursday, 1030-1200: NAVAL OCEANOGRAPHY
The Environment and Mine Countermeasures
Ms Lisa Tubridy, Naval Coastal Systems Station

Environmental Support for Mine Countermeasure
Dr. Peter Chu & LCDR Eric Gottshall, USN, Naval Postgraduate School

Battle Space Awareness: Software Engineering Issues and the Natural Environment
Mr. James Corbin, Mississippi State University Center for Air/Sea Technology

Leading the Change in Naval Oceanography
Dr. Theodore Bennett, Jr.; Mr. Landry Bernard, III; Mr. Mitchell Shank; and Mr. Robert Starek; Naval Oceanographic Office

Thursday, 1330-1500: WEATHER & WARFARE
Requirement for Dedicated Staff Meteorological Support in Test and Evaluation
Mr. John Elrick and CAPT Rodney Clements, USAF, Air Force Operational Test and Evaluation Center

High-Resolution Climatology
Mr. Gary McWilliams, Executive Agent for Air and Space Natural Environment

Impact of Weather Data Accuracy on Vehicle Performance
Ms C. Denise Bullock and Ms Patricia Sullivan, Geotechnical Laboratory, U.S. Army Engineers Waterways Experiment Station

Concept of Operations for Running and Exploiting a Mesoscale Forecast Model
Mr. Larry Phegley, Mr. B. John Cook, Dr. J. Schmidt, Ms S. Chen, Mr. P. Tsai, Naval Research Laboratory and Mr. William Burnett, Commander, Naval Meteorology nd Oceanography Command

Effects of Temporally Correlated and Non-Correlated Weather Data on Laser and Sensor System Design Parameters
Mr. Dwayne Pribik, Ms Larrene Harada, Mr. Fred Marcell, Schafer Corporation; Mr. Joung Cook, Naval Research Laboratory; and Dr. William Wilcox, Schafer Corporation

WG 11 – Military Environmental Factors – Abstracts
Room: R-240

Tuesday, 1030-1200: WEATHER IN MODELING & SIMULATION AND WARGAMES
Inserting Weather into Simulation-Based Acquisition

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One of the ways in which Acquisition Reform is being implemented within the Department of Defense is through the use of Modeling and Simulation throughout the system acquisition cycle, also known as "Simulation-Based Acquisition" (SBA). In November, Air Force Acquisition Policy (AFAP) 97A-004 mandated use of M&S applications and databases throughout the acquisition life cycle, with the goal of making the process more efficient and effective.

Implementing SBA is very involved. Consideration of High-Level Architecture compliance, development and maintenance of Digital System Models (DSMs), and minimizing "bending metal" while maximizing simulation-based design and prototyping are daunting tasks unto themselves. Consideration of the natural environment and its effects is complicated enough in the real world, without trying to figure out how to do it in the virtual one. This talk will focus on SBA as outlined in AFAP 97A-004, and describe from a conceptual view how the natural environment and its effects can be integrated into the process.

To incorporate natural environmental effects into SBA, one must start by examining each step of the system acquisition life cycle and the appropriate integration of M&S into the cycle. Next, an assessment must be made of the adequacy of the M&S "tools" (i.e., models and data) available for use at those stages in terms of their treatment of the natural environment. Here are two illustrative examples taken from Table 1 of AFAP 97A-004. In the first example, theater and campaign-level M&S are being employed in both Mission Area Assessments and Mission Need Statement stages of Pre-Milestone 0. Our analysis reveals that the models and simulations employed (especially at the campaign level) provide an inadequate treatment (or no treatment) of the natural environment and its effects. A second example comes from the Program Definition and Risk Reduction phase (Milestone 1 to 2). Here, system/engineering level models and simulations are applied. Since we know that such models and simulations are largely physics-based, we reason that it is possible to integrate the effects of the natural environment through adaptation of the appropriate physics-based atmospheric and space environment models. Analysis of the M&S tools available in the above two examples can serve as a means to help the environmental M&S community develop an appropriate strategy for integrating environmental effects into SBA. An example of such a strategy is shown below:

1) Integrate natural environmental effects into system/engineering M&S by identifying appropriate physics-based atmospheric and space environment
   models and adapting them to support system/engineering level simulations.
2) Improve the natural environmental treatment in those theater and campaign-level models used in developing the operational needs that translate into Milestone 0 activities such as Analysis of Alternatives.

A concurrent, third strategy looks at the DSMs being developed by various Acquisition activities, and how environmental effects can be communicated to those DSMs. This is important because DSMs are pervasive throughout the entire life cycle in SBA. The strategy is concurrent because it is more of a system architectural issue. In this case, the environmental M&S community must develop means of "affecting" performance of simulated weapon systems through incorporating environmental services into "architectures" such as the Joint Modeling and Simulation System (JMASS). As in all analyses of this type, trade-offs must be identified and considered. In this case, the risk of "uneven" treatment of the natural environment from engineering to campaign levels must be evaluated if we decide to pursue the engineering and DSM-level integration solutions first.

The "end game" of these integration efforts should be the development of a means to evaluate the environment's effects on the performance of proposed systems while they are still on the "virtual drawing board." A robust test and evaluation capability (i.e., virtual test environment) is also needed to support the system from Milestones 1 to 2 and beyond. In all these activities, the environmental models and simulations should be used with an eye towards identifying those portions of the environment which can be "exploited", much in the same way as the Electromagnetic spectrum is exploited in the Electronic Warfare business. A crucial piece to developing such an exploitation strategy is a better understanding of Opposing Forces' weather sensitivities, requiring a closer working relationship between the environmental and intelligence communities. While some of the strategies outlined in this talk could take years to implement, there are technologies available in the environmental M&S community today that can be "harvested" for use in "fast-track" projects to demonstrate many of the concepts described in this talk.

The Weather Scenario Generator

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The Weather Scenario Generator (WSG) project is developing a prototype system architecture that demonstrates the automatic generation of customized atmospheric databases. The WSG project has the explicit goals of providing an intelligent search mechanism for

locating desired atmospheric conditions within archived datasets and providing a just-in-time production capability for generating customized, realistic scenarios. The Defense Modeling and Simulation Office (DMSO) is sponsoring this project because it will benefit a wide range of customers within the modeling and simulation community who need physically consistent, integrated atmospheric datasets. This presentation will discuss the WSG system architecture, its concept of operations including its accessibility through the Master Environmental Library (MEL) and its future development plans that space and oceanographic data.

Weather Wargame Series

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The Air Force Research Laboratory (AFRL) will conduct a series of wargames in Fiscal year 1998 designed to demonstrate technologies for incorporating weather and it's effects into distributed simulation. Called the Weather Wargame Series, the purpose is to incrementally develop and demonstrate USAF weather modeling and simulation (M&S) capabilities leading to participation in larger USAF-wide exercises. It is intended to provide the USAF weather M&S community with the ability to establish support for USAF M&S activities while leveraging technology developed by DARPA and other M&S agencies.

Initially, the wargames will demonstrate the generation and distribution of weather data, as well as the calculation of weather effects, including cloud obscuration, in air-to-ground and long-range missile detection engagements. The weather will be generated by the Air Force Weather Agency. Weather data distribution will be accomplished using DARPA's TAOS Weather Server. Weather effects will be generated by physics-based weather server developed by AFRL/VSSW and called the Atmospheric Effects Server (AES). The AES provides computer generated forces with rea;istic weather impacts that affect the outcome of the individual engagements. The Weather Wargames will use TAOS and the AES to impact a 500-entity wargame generated by the AF/XO's Theater Battle Arena (TBA) at the Pentagon and linked to AFRL/VSSW via a high speed encrypted line.

The Weather Wargame Series is an ambitious program that seeks to advance the state of environmental representation in distributed simulation.

Environment Modeling in War Games

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The Army Research Laboratory, in collaboration with the Air Force Research Lab and the Naval Research Lab, has been improving and modernizing many of the legacy models describing environmental phenomena. Examples of these legacy models include the battlefield obscurants model, COMBIC, and the slant-path atmospheric transmission model, XSCALE. In addition, new models are in development that more accurately portray turbulence and radiative transfer. Some of the changes are more significant in that the output results from the model are changed; other changes impact only the coding efficiency of the model and/or operations in a High Level Architecture environment. Since these models are component units in many war games (e.g. in JANUS, ModSAF) the changes can impact the predictions of these games. However, there has been no directed DoD effort to ensure that the latest versions of the atmospheric models have been incorporated.

This paper documents a study that has been initiated to examine a number of war games, beginning with JANUS, ModSAF, JSIMS, and JMASS, to determine how the environment is currently played in these games. Out focus will be on the specific environmental sub-models that are part of the EOSAEL and WAVES modeling packages. Parameters needed for these models to run will be verified and the presence of parameters for the newer models will be established. Input is being sought from the modeling community on the importance of further improvements and changes in these models.

Tuesday, 1330-1500

COMPOSITE GROUP B SESSION.. Room G-109

Wednesday, 0830-1000: ENVIRONMENTAL APPLICATIONS OF SPACE SYSTEMS, ESPECIALLY COMMERCIAL IMAGERY SYSTEMS

Joint Session with WG 5 & 6.. Room G-102

Naval Oceanographic Applications of Space Systems

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The Naval Oceanographic office (NAVOCEANO) is charged with acquiring and analyzing global ocean and littoral data to provide specialized, operationally significant products and services for warfighters, and civilian, national and international customers. Historically, the bulk of these data have been collected by NAVOCEANO's fleet of oceanographic survey ships. However, in 1987 NAVOCEANO established the Operational Oceanography Center (now the Warfighting Support Center (WSC)) in order to provide near-real time oceanographic products to naval warfighters. The National Oceanic and Atmospheric Administration's (NOAA's) Polar-Orbiting Environmental Satellites (POES) and the Navy's Geosat altimetry satellite were the primary sources of broad area, real-time oceanographic information in the late 1980s.

As the Cold War ended, NAVOCEANO continued to support deep ocean, "bluewater" naval operations, but rapidly increased its product line for the warfighter conducting and planning operations in littoral areas. Timely assessments of bathymetry, currents, visibility, temperature, and waves are critical parameters for these operations. During the last several years, NAVOCEANO has greatly expanded its use of commercial imagery (e.g. Landsat Thematic Mapper and SPOT imagery) to characterize the oceanographic component of the battlefield environment. The role of these and other space-based systems in producing NAVOCEANO products is described.

Recognizing the key role to be played by space-based remote sensing in conducting its core business over the next twenty years, NAVOCEANO has developed a strategic plan for remote sensing. The key components of the plan are described.

An Overview of Orbital Imaging Corporation's Satellite Imaging Services

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Orbital Imaging Corporation (ORBIMAGE) is a majority owned subsidiary of Orbital Sciences Corporation established to develop, launch, and operate commercial earth imaging satellites. ORBIMAGE is leading Orbital's entry into the expanding market for satellite-based Earth imaging services.

ORBIMAGE will employ a uniquely integrated global system of imaging satellites, ground stations and Internet-based sales channels to collect, process and distribute its imagery products. ORBIMAGE currently operates OrbView-1, an atmospheric monitoring satellite launched in 1995 and OrbView-2 launched in August 1997. OrbView-2 carries the SeaWiFS instrument, a land-ocean color multi-spectral payload which images most of the earth's surface on a daily basis. The satellites are operated from our Dulles, VA satellite and mission operations center. OrbView-2 represents a unique government-commercial collaboration in which SeaWiFS was developed and flown under terms of an advance data purchase agreement with NASA. ORBIMAGE is now developing commercial products for SeaWiFS such as precise fish-finding maps for the fishing industry.

ORBIMAGE is currently developing the OrbView-3 & 4 spacecraft –systems designed to provide high-quality one meter resolution panchromatic imagery and four meter resolution multi-spectral imagery. ORBIMAGE was also recently awarded a contract by the U.S. Air Force for the development and operation of the "Warfighter-1" hyperspectral imaging payload to be flown on OrbView-4. OrbView-3 & 4 are scheduled for launch in 1999 and 2000, respectively.

ORBIMAGE is actively developing commercial applications and customers for all OrbView imagery products. Product applications include markets as diverse as precision agriculture, mineral exploration, mapping, and national security. We are focused on meeting future government imagery requirements addressable by OrbView-3 & 4 in a manner that provides substantial cost savings to the government. This provides the dual benefit of expanded markets for commercial suppliers while allowing the government to focus their investments on systems servicing the most stressing government-unique needs.

This presentation will focus on the design, operations, and products of our commercial imaging systems.

EarthWatch, Incorporated

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EarthWatch, Incorporated is launching a constellation of commercial high-resolution satellites (0.8 meter panchromatic and 3.3 meter multispectral) known as QuickBird 1 and QuickBird 2 and offering Digital Globe™ services to customers worldwide.

The Digital Globe™ is the first global multipurpose geographic information database of the planet incorporating imagery, digital elevation models, map products, and other data from a variety of sources.

On-line access to the Digital Globe™ via the Internet provides customers with easy, direct-to-desktop Digital Globe™ products to support a wide range of applications, including support to the warfighter. High-resolution commercial imagery can provide valuable information about the environment and the battlespace in a way never before achieved utilizing unclassified sources.

In addition, EarthWatch offers direct downlink services to ground stations worldwide which provides timely access to high resolution imagery data for customers with time sensitive requirements.

The Digital Globe™ database and distribution network serves the geographic information needs of customers in areas such as national security, land development, environmental monitoring, land management, oil and gas exploration, transportation, agribusiness, and mapping.

Commercial Remote Sensing Can Change the Environment of Military Forces

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The Commercial Remote Sensing Systems business is to provide Earth information worldwide. The recent report by the Brown Commission discusses the need by the United States forces for "information about the world outside its borders to protect its national interest and relative position in the world, whether as a Cold War superpower or a nation that remains heavily and inextricably engaged in world affairs. It needs information to avoid crises as well as to respond to them, to calibrate its diplomacy, and to shape and deploy its defenses." Much of this information today is available from National Intelligence Capabilities, but much of it is not. In addition these capabilities are costly and often have competing interests among the various DOD and intelligence organizations. The potential for commercial remote sensing systems to augment the information needs provided by national assets is high and likely to be significantly less costly.

The data collected by these commercial remote sensing companies will supply Imagery Map products that generally can be categorized into Imagery Interpretive Products and Map Products . The potential for applying this information rich data and the resulting base imagery, whether interpretive or map products to new and future naval requirements, and to be able to provide a strong insight into the environments of our military forces will confront is significant. Commercialization will allow software vendors and companies working directly with the users of the data to expand this development process more rapidly and have it available at lower costs. In addition many of the commercial applications are equally applicable to Naval interests. For example, algorithms trained on specific crops for determining crop yields, can be trained on ocean plant life, allowing better assessments of navigational potential near coastal waters. More precise land-coastal demarcation is possible through the use of high-resolution remote sensing data. Remote sensing data available to ships at sea about their regions of interests will enable ongoing and currency of mission planning. It will enable the layering of information to be more clearly understood and clarify the important considerations to be made. The remote sensing data also provide a better base image for future sensors, such as hyperspectral, whose data becomes more attractive and of potentially greater value when used in conjunction with accurate base imagery data.

Current Naval leadership perceives three areas which drive Navy objectives not just for today but for the future as well: Forward presence; Engagement; and Fight to Win. Information available from commercial remote sensing systems can contribute to supporting each of these areas. Remote sensing data will allow the Navy to intelligently understand the potential for forward presence and to reduce vulnerability by making use of information rich timely data available directly to these forces. Engagement will benefit in being able to task the sensors directly and obtain remote sensing data within minutes and for the area of interest. Fight to Win will benefit from data available in planning attacks as well as for assessments of success of operations and evaluations of enemy engagements. In addition because much of this data will be archived, use of archived data with new data will allow a more comprehensive assessment to be made worldwide as the perceived foreign military threat is projected. How efficient and effective the Navy makes use of these new Commercial remote sensing systems and the seamless integration of these and other data into Information and Warfare may dictate the shortfalls of the navy's capability for the future and the adequacy of the military forces in understanding the environment.

Wednesday, 1030-1200: ASSESSMENT OF SATELLITE SYSTEMS

Joint Session with WG 5 .... Room G-102

Quantifying the Military Value of Weather Information in an Air Campaign

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Although the Gulf War has been touted as the first war where the use of space assets was fully realized, the Air Force has been exploiting space based weather satellite systems for years. Analytically, however, past efforts have not adequately quantified the contribution of these systems to the warfighter. The Air Force Research Lab Space Vehicles Directorate and the Air Force's Office of Aerospace Studies worked together using a community-accepted weather simulation model in conjunction with the Combat Forces Allocation Model (CFAM) to develop a beter quantification of the value of these systems. We present a comparison of two candidates for the National Polar-Orbiting Satellite System (NPOESS) using this methodology.

Determine Military Utility of a Weather System

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Campaign and mission models have been used extensively to support analyses concerning weapon trade-offs, force structure, modernization, concepts, targeting decisions and munitions inventories. Currently weather and associated effects are either lacking or poorly

represented in these models. Thus the weather community has little ability to demonstrate military worth of improvements in weather representation and forecasting. This was the challenge in evaluating the military utility of the National Polar-Orbiting Environmental Satellite System (NPOESS) and comparing it to another weather satellite system.

For an initial effort and since the NPOESS was still in the definition phase, only the differences in the horizontal resolution of system's outputs or weather parameters were examined. Parameters used were those to determine cloud ceiling, visibility ranges and line-of-sight attenuation of target signature. This information was incorporated, as a weather forecast, into the Air Force's Combat Forces Assessment Model (CFAM). CFAM, a linear optimization program, uses the forecast information to determine weapon-target parings or weapon loadouts. CFAM then executes a campaign by "flying" against weather "truth" which is correlated to the forecast. Warfighting results, e.g. length of campaign, total sorties, number of sorties aborted due to weather and others, are generated by CFAM.

Weather "Truth" was generated by using Penn State's Mesoscale Model 5 (MM5) for a Korean scenario which was the source for the forecast generation. CFAM using the same scenario and MM5 weather was run with the different loadout or forecast. CFAM using NPOESS derived forecast based on better horizontal resolution had better results with a shorter campaign, less sorties flown and less weather aborts. The degree of differences correlated with weather severity; more severe the weather, greater the differences.

This initial effort to determine military utility of a weather system was successful but limited. Efforts will continue looking at target thermal contrast, NPOESS sensor(s) utility, system refresh rate and accounting for other unique NPOESS parameters.

Surveillance Satellite Constellation Analysis

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This paper describes measures of surveillance constellation performance and the principles of constellation design. We have discovered that the C4ISR community in general lacks fundamental grounding in these disciplines. This paper will provide a straightforward, comprehensive tutorial for the analytical community that supports C4ISR decisions. We will describe our work in support of the Future Imagery Architecture Senior Warfighter Forum, a body recently convened by the Joint Staff to adjudicate future imagery and space based radar requirements. We will demonstrate the characteristics of a variety of generic surveillance constellations and develop commonly accepted measures of constellation performance. We will show how microscopic performance varies from aggregated measures of merit, some of which are often applied inappropriately. Our paper will show coverage of selected areas of the world as a function of time, and it will demonstrate synergism among different constellations at diverse altitudes. As military operations move toward the goals of Joint Vision 2020, more missions will rely on space systems. MORS and the analytical community that supports this transition must understand better the fundamentals of constellation design.

Simulation of Communications, Command, and Control for Warning and Defense

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A simulation of the networks that provide information for warning of and assessing air breathing and ballistic missile attacks on North America became operational last Fall at NORAD and USSPACECOM. The simulation was benchmarked against comprehensive tests of system performance conducted in Feb 1997. The simulation includes all nodes, links, buffers, and processors from early warning sensor outputs, through Cheyenne Mountain, and to designated forward users. It incorporates complete buffer logic, network protocols, and processing delays. The simulation demonstrates modern software and system engineering. The logic flow and objects that participate in the simulation are a complete functional diagram of one of the most complex and comprehensive military networks in the world. The attributes of the objects in the simulation constitute a complete and accurate statement of the configuration of the system. The simulation itself was created in modern object oriented computer language. This permits us to change processor characteristics, buffer logic, and protocols as well as being able to add new links and system elements easily. The simulation predicts message loss and latency among all elements of the system. Real world assessments of warning system performance are labor intensive and expensive. Some system characteristics may have change between tests. The simulation allows us to assess the variance among measures of performance from test to test. We have already determined the statistical distribution of message latency among many elements of the warning system. We have discovered that the longest and shortest time delays previously used to characterize system performance do not represent system performance adequately. We can predict how the system might have performed if the configuration or other external stimuli were unchanged. This establishes continuity among tests conducted under widely varying circumstances. The simulation opens a new dimension for decisions about the configuration of the Nation's strategic defenses and warning. Heretofore, we assessed the adequacy of the warning systems by considering only how the coverages of diverse sensors complemented each other. Now we can determine whether sensors with wide coverage can communicate their detections in a timely and accurate manner. We already have examples of sensors under heavy load being unable to communicate warning information expeditiously. During the next few months we will trace individual ballistic missile threats through the system and bound the performance envelope of this important strategic asset.

Wednesday, 1330-1500: ENVIRONMENT & SPECIAL OPERATIONS

Joint Session with WG 16 .... Room G-102

SOF-MEM: A Frontal Assault on the "Critical Meteorological and Oceanographic Thresholds for SOF Operations"

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At the 65th MORSS we gave a presentation detailing the development and architecture of a decision support system (DSS) for relating environmental factors to mission effectiveness (*The Special Operations Forces (SOF) Mission Effectiveness Model (MEM): A Fuzzy Logic Decision Support System*). In this presentation we will discuss the use of threshold values for tactical decision making contained in the "Critical Meteorological and Oceanographic Thresholds for SOF Operations," and show how the use of discrete parameters in decision making, in both human and computer based decision making, can be extremely dangerous and lead to poor decisions. We will also discuss how experienced tactical decision makers correctly use these parameters as guidance, and how a fuzzy decision support system, such as the Special Operations Forces (SOF) Mission Effectiveness Model (MEM) incorporates these same parameters.

An Intelligent Analysis Methodology for Military Reconnaissance and Surveillance Missions

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The Army's vision of the future battlefield consists of groups of networked organizations organized around information and information technology that supports the capability of reacting to dynamic situations. The fielding of such technologies will make information abundant and dynamic and will undoubtedly create new challenges for future commanders and their staffs. If the goal is just to distribute information, the challenge becomes the staff's ability to decipher the information that is critical and effectively apply this information in the decision process. Future C2 systems must go beyond the capabilities of today's information systems by incorporating artificial intelligence (AI)-based decision support tools necessary to allow these systems to become a part of the staff rather than just a tool used by the staff.

One of the most difficult tasks that military planners are required to perform is the generation of reconnaissance plans thereby providing human surveillance of a specific site. The first two fundamentals of recon planning are: gain all required information; and avoid detection. If the planner can successfully balance these two competing goals there is a far greater likelihood that a particular mission will be successful.

This paper presents a first step in the development of a fuzzy logic process that addresses the competing goals of reconnaissance planning and produces recommended recon team locations that address the issues of gaining the required information and at the same time allows the recon team to avoid detection.

METOC Support to Military Operations Research: Special Operations Forces

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Knowledge of the impact of Meteorology and Oceanography (METOC) conditions on both friendly and opposing forces is vital to the planning, rehearsal, and execution of military operations. Environmental factors can serve as cover, or as an impediment to operations. METOC conditions affect mobility, weapon/sensor performance, communications, life support, and risk to personnel and equipment. Exploiting tactical knowledge of environmental conditions acts as a force multiplier, increasing the probability of success. To provide warfighters a decisive tactical advantage, a thorough understanding of the spatial and temporal variability of METOC parameters is required. These environmental parameters include atmospheric conditions, ocean dynamics, water column properties, seafloor properties, biological hazards, hydrological conditions, and coastal characteristics. This information is essential for conducting military operations research.

Special Operations Forces (SOF) mission planning and execution involve a continuous series of choices in response to a dynamic set of environmental and tactical conditions. To help mission planners and decision-makers appreciate the impact of the METOC environment on platforms and personnel, a document entitled Critical Meteorological and Oceanographic Thresholds for SOF METOC Operations is published by the United States Special Operations Command. A review of this document is provided.

Support to SOF dictates the requirement for accurate environmental data in the littoral zone on current and expected (modeled) conditions. SOF operations exert stringent requirements, both spatially and temporally, on environmental models and data collection systems. Models and collection methods that were successfully used to support "blue water" requirements cannot easily be transitioned to the littoral environment. The problem is one of both scale and environmental complexity. An evaluation of present capabilities to measure and predict the METOC parameters required to support SOF mission planning, rehearsal, and execution is provided. Expected near-term and far-term advances in modeling and remote sensing technology areas that show promise for addressing these deficiencies are presented.

To support military operations research systems effectively, the discovery and dissemination of METOC information must be standardized to facilitate rapid access and accurate fusion with other digital information. Issues associated with this concept, such as metadata fields, data models, data interchange mechanisms, and the development of METOC Geographic Information Systems, are discussed.

Joint Session with WG 12 .... Room G-102

Representing Ground Vehicle Mobility in Virtual Environments with Relevance to Materiel Development and Tactical Trainers

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Virtual Environments are being increasingly utilized by the military to conduct vehicle assessments and training with ground vehicles. While off-road vehicle mobility modeling for military analysis has traditionally concerned steady-state, maximum achievable vehicle speed attainable over relatively large, nominally homogeneous areas, advancing applications in Virtual Environments require higher-resolution representation of soil-traction element interaction. The vehicle-soil/surface response must be realistic at higher-resolution scales for effective use and analysis with or without the human-in-the-loop. The U.S. Army Engineer Waterways Experiment Station (WES) has recently developed a baseline physics-based capability to model soil-traction element interaction at less-than-maximum potential for higher-resolution scales. The research objectives involved developing a soil response model to characterize load-motion resistance-sinking relationships, linking soil response and vehicle dynamics algorithms, and evaluating results via field experiments. Selection of mobility factors and spatial resolution were considered. Model methodology and results will be presented with an emphasis on advancing mobility representation in Virtual Environments.

The JCATS Terrain Model and Its Effects on Conflict Simulation

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The Joint Conflict and Tactical Simulation (JCATS) is the latest conflict simulation to be developed at the Lawrence Livermore National Laboratory (LLNL). JCATS is a multi-sided, interactive, entity-level simulation utilized by military and site security organizations. It is used as an exercise driver and tool for training, analysis, and mission planning. The primary sponsor of JCATS is the Joint WarFighting Center (JWFC). Users of JCATS simulation include US Army, Air Force Security Forces, US Special Operations Command, US Marine Corps, US Southern Command, US Army Europe, Department of Energy, and US Secret Service.

JCATS merges the capabilities of two other LLNL developed simulations, the Joint Tactical Simulation (JTS) and the Joint Conflict Model (JCM). It provides a rich environment of integrated capabilities that are used for the simulation of combat, security exercises, and Operations Other Than War. Among the capabilities provided by JCATS are detailed modeling of rural and urban terrain, dynamic aggregation and de-aggregation of entities, lethal and non-lethal effects of munitions, and day and night operations. Entities that can be modeled include group forces, fixed wing aircraft, helicopters, and water craft.

The element that ties together all the other elements of a simulation is the playbox terrain. JCATS usage ranges from small exercises utilizing a handful of entities in a one square kilometer playbox, up to large division-level exercises utilizing thousands of entities and aggregates on a 1000 square kilometer playbox. An extensive set of terrain features is utilized by JCATS in its adjudication of combat. The terrain model includes terrain elevation, vegetation, pavement, lakes, rivers, buildings, doors, walls, windows, area and spotlights, fences, and unattended sensors. A handful of dynamic terrain objects such as foxholes and barriers are also simulated in the JCATS environment. The assessment of movement, acquisition, shooting effects, and all other aspects of simulated combat are affected by the terrain model in JCATS. This presentation wil provide a general discussion of the terrain model in JCATS and how it is used to give a realistic portrayal of combat and peace keeping operations.

The JCATS Lighting Model and Its Impact on Simulated Conflict

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Approved abstract not available at printing.

Transportation Infrastructure Assessment

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The Transportation Infrastructure Assessment Module (TIAM) is being developed by the US Army Engineer Waterways Experiment Station as the prototype general engineering component of the Engineer Operations System (E-OPS) with a specific focus on the engineer

interface with logistics and transportation operations. The TIAM is designed as a decision support tool to be used by the engineer in analyzing road networks during planning for initial usage and maintenance and rebuild phases for the transportation network. Support for military sustainment engineering operation within an operational theater are provided by the following capabilities in TIAM: evaluation of the impact of environmental factors on the maximum throughput along selected routes, identification of potential logistics support areas, estimation of road life based on expected or actual traffic flow, analysis of engineer work effort required to maintain and repair roadways. The purpose of this presentation is to discuss TIAM functions and applications.

Thursday, 1030-1200: NAVAL OCEANOGRAPHY

The Environment and Mine Countermeasures

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A successful power projection campaign may require operations through littoral defenses including mines. Mines are the most prolific weapons available to other nations intent on inhibiting U.S. Naval forces ability to project power from the sea. Therefore, mine countermeasures (MCM) are integral to the overall power projection campaign. Countering the mine threat is critical to naval forces ability to effectively shape and dominate the battlespace. Future MCM operations are expected to be carried out primarily in shallow water coastal regions. Shortened scales of temporal and spatial variability in both the atmospheric and oceanic regimes characterize these regions. Combat system sensors must be environmentally adaptive in order to use the environment to a tactical advantage. This presentation describes how the fleet presently uses environmental data and the analysis required to predict performance in the littoral regions.

Environmental Support for Mine Countermeasure

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Meteorological an Oceanographic (METOC) data collected through surveys designed to support the mine warfare community must have a resolution commensurate with both the degree of natural variability and the effect this variability has on safe and successful conduct of the operations being supported. The guidance provided with the current SAFECUR TDA gave no indication of the potential hazards involved in using the TDA over regions of varying conditions. While the user could be reasonable expected to calculate maximum safe current values at several locations in their area of interest, the variation between adjacent MACAS survey points is large and no guidance on interpolating between such points is available. Does METOC variability such as this concern other TDAs and to what extent can changes in verification and validation procedures identify them? The study of environmental effects on naval warfare simulations as a subject area is exceedingly broad in scope. Operations analysts can concentrate their expertise and apply their detailed knowledge about a single simulation to a myriad of problems. The METOC professional must become a near expert on every simulation they use if they are to effectively employ METOC in them. METOC variable values and their variation possess attributes that uniquely effect both the physics and the psyche (soft factors) of naval warfare.

Battle Space Awareness: Software Engineering Issues and the Natural Environment

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In warfare, a common understanding of the natural environment among the distributed warfighters and the integration of this understanding with weapons systems and Tactical Decision Aids leads to Dominant Environmental Awareness as a subset of Dominant Battlespace Awareness. However, the heterogeneous mix of computing resources, communication systems, data types and formats, etc. makes the seamless exchange of data a formidable problem.

Some progress has been made using common data exchange formats and programming interfaces, but the solution is far from optimal. It is difficult, if not impossible, to get agreement from all concerned interests on the Standards. These Standards take too long to develop and implement. Finally, the accommodation of unanticipated changes can be difficult and expensive.

This paper considers an approach to this issue based on object oriented software engineering. Such an approach readily accommodates changes and significantly reduces the overhead needed to manage the data systems. Much of this technology exists. However, an emphasis on short-term enhancements of present capabilities impedes a longer-term investment in a genuinely seamless capability.

Leading the Change in Naval Oceanography

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How will naval oceanography adapt to the uncertain challenges in threats, warfighting concepts, and technology that will dominate the next decade? Fresh ideas are imperative, but not sufficient. Leading organizational change to meet these challenges requires a structured management approach to identify the needed changes, build the organizational momentum to accept change, and execute the strategies for change.

A strategic management approach based on the Government Performance and Results Act (GPRA) is a common-sense approach for leading change. Strategic management has five major phases. They are 1) envision the future and your role in it, 2) prepare a strategic plan that identifies your goals for the future and your strategies for realizing these goals, 3) build an investment strategy that optimally matches often scarce resources to your strategic plan, 4) implement your plan, and 5) assess the outcomes of your actions. The Balanced Scorecard is a powerful tool for cascading corporate goals down through the organization and bringing performance measurements up to the corporate level.

This presentation summarizes the experience of the Naval Oceanographic Office (NAVOCEANO) with the first three phases of strategic management. Inputs for this presentation come from NAVOCEANO's senior management, a vision group, and the Information Technology (IT) management. The vision group has a broad charter to consider plausible 2010 threats, warfighting concepts, and technologies; develop a synthesis; propose a role for naval oceanography; and identify the technologies that will be critical to naval oceanography in 2010. The implementation of NAVOCEANO's new IT Strategic Plan is a testbed for the application of the Balanced Scorecard.

Thursday, 1330-1500: WEATHER & WARFARE

Requirement for Dedicated Staff Meteorological Support in Test and Evaluation

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The value of high technology was clearly demonstrated during the Vietnam Conflict. Electro-optical systems were employed against high-vale/high-risk targets with impressive results. Since then, new developments have spawned more complex systems for the armed services. "Electro-optical" systems operate in all areas of the electromagnetic spectrum from sub-visible through millimeter wavelengths. Sophisticated space-based systems are becoming critical to effective battlefield management activities. The natural environment affects all these systems in complex ways previously ignored or not understood. With the current trend toward austere budgets and shrinking personnel resources, future testing requirements will be achieved through modeling and simulation. It is essential that computer applications thoroughly and accurately simulate the operational environment. It is the task of the Air Force Operational Test and Evaluation Center's Staff Meteorology Office to identify potential environmental shortfalls of advanced systems and ensure these meteorological conditions are identified and limitations understood before systems enter the operational military inventory.

High Resolution Climatology

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Currently, climatological data for many regions of the world are only available at a coarse resolution not sufficient to optimally support military needs. This problem is most evident in littoral regions where steep gradients in climatological statistics are often found due to the presence of mountain ranges and marine influences. To remedy this problem the Defense Modeling and Simulation Office is sponsoring the High Resolution Climatology project. This project is developing a prototype modeling system that will create 3-D, hourly climate statistics at horizontal resolutions of 40 KM and 10 KM. The basic component of this system is a dynamical-numerical atmospheric model that can be initialized and bounded using the 40-year archive from the National Center for Atmospheric Research (NCAR)/National Center for Environmental Prediction (NCEP) Global Data Assimilation System (GDAS) Reanalysis project. As a proof of concept, high-resolution climate statistics are being generated for Korea and the Middle East. When this modeling system becomes operational, users will be able to request and receive its data over the Internet using the Master Environmental Library (MEL). Modeling and simulation applications needing high-resolution data range from engineering design to campaign planning.

Impact of Weather Data Accuracy on Vehicle Performance

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Weather, in terms of precipitation, influences vehicle performance as it influences the change in soil moisture and corresponding soil strength. Soil moisture is generally measured between ranges of field maximum (fully saturated) and field minimum (residual soil moisture). Between this range, the soil strength varies from a minimum to a maximum which translates to the ability of the vehicle to achieve minimum to maximum traction or tractive force. Tractive force is that resultant force, obtained after overcoming motion resistance to the operating soil surface, that propels the vehicle forward. Therefore, in order to quantitatively assess weather's impact on vehicle performance, one must determine how much precipitation is required to affect a change in soil strength and the effects of changes in soil strength on vehicle tractive force and related speed. The results of a recent study at WES indicate a requirement for rainfall measurement accuracy within 0.01 inch to accurately represent vehicle performance. The substance of that study will be presented.

Concept of Operations for Running and Exploiting a Mesoscale Forecast Model

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In June 1997, the Naval Research Laboratory successfully demonstrated the On-sceneTactical Atmospheric Forecast Capability (STAFC) at sea aboard the USS Nimitz during a transit from Bremerton, Washington to San Diego, California. In late spring, the same capability will be placed at the Naval Pacific Meteorology and Oceanography Facility, San Diego for an extended period of evaluation. This paper wil provide a very brief overview of the data fusion and forecasting capabilities of STAFC, review the communications used to support the model onboard USS Nimitz and present the Commander, Naval Meteorology and Oceanography concept of operations for the operational implementation of this capability.

Effects of Temporally Correlated and Non-Correlated Weather Data on Laser and Sensor System Design Parameters

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Washington, DC 20375

Dr. William Wilcox
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Laser and sensor systems are normally designed using average weather data for estimating performance variability of the system. Assuming statistically averaged values for temperature, humidity, and wind speed and their standard deviations, results in laser power requirements 3 to 4 times greater than when using correlated weather data. The authors present the effect of correlated weather data on scattering and absorption coefficients using FASCODE, MODTRAN, and the Navy Aerosol Model (NAM). As well as correlation of aerosol absorption and wind speed for use in thermal blooming calculations. FASCODE analyses were performed for 1.045, 1.315, 1.623, and 3.8 micron wavelengths. The database used is a 15-year correlated weather data set from the National Center for Atmospheric Research consisting of observations from the Sea of Japan, Strait of Hormuz, and eastern Mediterranean. The resulting 15-year histories of calculated propagation give a realistic performance envelope for use in laser and sensor system development and result in lower power and sensitivity levels to meet mission objectives.

WG 12 LAND & EXPEDITIONARY WARFARE - AGENDA

Chair: Dr. Ephraim Martin, Lockheed Martin Electronics & Missiles
Cochair: Mr. Thomas J. Iten, Raytheon E-Systems
Cochair: MAJ Dennis Boykin IV, TRAC
Cochair: Mr. David Long, TRAC
Advisor: Mr. Larry Cantwell, TRAC

Room: G-110

Tuesday, 1030 - 1200
Stochastic Analysis for Deployments and Excursions (SADE)
LTC Patrick J. DuBois, Ph.D., US Army Concept Analysis Agency

Southwest Asia Low Resolution Scenario (SW LRS) 7.0
MAJ Charles E. Davis, TRADOC Analysis Center

Northeast Asia Low Resolution Scenario (LEA LRS) 3.0
CPT Jeffrey S. Smidt, Operations Research Analyst, TRADOC Analysis Centerrum, air, sea and land.

Tuesday, 1330 -1500
Heuristic Military Analysis
MAJ Jon J. Peterson, Combat Operations Analyst, TRADOC Analysis Center

The JWARS Battlespace Entity, An Example of a Computer Generated Forces Structure Addressing Varying Levels of Aggregation
Mr. Denis T. Clements, Project Manager and Mr. Michael A. Goshorn, Lead Software Engineer, JWARS Office

A Generic Parameterized Model of Active Protection Systems for Military Vehicles
Mr. John D. Pinder, Doctoral Fellow, RAND Graduate School

Wednesday, 0830 – 1000
COMPOSITE GROUP C SESSION.. Room G-109

Wednesday, 1030 – 1200
Warfighting Analysis in a Ruck Sack (WARS)
Wm. Forrest Crain, Colonel, Chief of Operational Capabilities Assessments, and David E. Bassett, Major, Senior Operations Research Analyst, US Army Concepts Analysis Agency

Breaking the Phalanx (BTP) Analysis
Wm. Forrest Crain, Colonel, Chief of Operational Capabilities Assessments, Steve Orloff, LTC, Senior Operations Research Analyst, U.S. Army Concepts Analysis Agency

Grizzly Requirements Analysis
CPT John Keeter, Military Combat Analyst and Patrick G. Smock, Senior Operations Research Analysis, TRADOC Analysis Center

Wednesday, 1330 – 1500
Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP) Requirements Analysis
Mr. Patrick G. Smock, MAJ John M. Harwig, TRADOC Analysis Center

Thursday, 0830 - 1000 Joint Session with Working Group 11/12
Joint Session with WG 11 & 12.. Room G-102

Representing Ground Vehicle Mobility in Virtual Environments with Relevance to Materiel Development and Tactical Trainers
Dr. Niki Deliman, Geotechnical Laboratory, U.S. Army Engineer Waterways Experiment Station

The JCATS Terrain Model and Its Effects on Conflict Simulation
Mr. Gary Friedman, Conflict Simulation Laboratory, Lawrence Livermore National Laboratory

The JCATS Lighting Model and Its Impact on Simulated Conflict
Mr. Thomas Kelleher, Conflict Simulation Laboratory, Lawrence Livermore National Laboratory

Transportation Infrastructure Assessment
Dr. David Horner, Dr. William Willoughby, and Dr. Niki Deliman, Geotechnical Laboratory, US Army Waterways Experiment Station

Thursday, 1030 - 1200 Working Group 12, Session 7
Investigation of the Effects of Active Protection Systems (APS) on Tactical Missile Systems
Ms. Jody F. Allison, PEO Tactical Missiles and Mr. Marvin S. Smith, Nichols Research Corp

Course of Action Analysis for Military Decision-Making
Dr. Robert S. Alexander, Science Applications International Corporation (SAIC)

Rapid, Flexible Deployment Planning Techniques Using the Strategic Lift Integrated Model
Jerry Butler, Coleman Research Corporation

Thursday, 1330 - 1500 Working Group 12 Session 8
Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling
Alan D. Zimm, Senior Professional Staff, Johns Hopkins University Applied Physics Laboratory

Quantifying The Value of Manned Reconnaissance in the Simulation of Land Warfare
Dr Ephraim Martin IV, Lockheed Martin Electronics & Missiles and Dr Michael Proctor

2 MTW 2010 Defense Planning Guidance Baseline Study
Major Robert A. Morris, Campaign Analyst, AFSAA

WG 12 – LAND & EXPEDITIONARY WARFARE – ABSTRACTS
Room: G-110

Tuesday, 1030 - 1200 Working Group 12 , Session 1
Stochastic Analysis for Deployments and Excursions (SADE)

LTC Patrick J. DuBois, Ph.D.,
US Army Concept Analysis Agency
Bethesda, MD 20814
Abstract: The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of the events to which the United States (US) commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily commits to Major Theater Wars (MTW) and Small Scale Contingencies (SSC). These types of operations occur increasingly more often and with much more uncertainty concerning event inter-arrival, duration, and the number/type of troops/equipment required. Due to recurring demands to justify force structure, the focus change and the increase in uncertainty inherent with these new types of operations, there is a need to forecast the number and type of operations the US Military will have to respond to simultaneously.

This paper discusses a methodology that is based on queuing theory and incorporates stochastic processes (simulation) using the simulation software AWESIM® to forecast the number of SSCs (by type) that the US Military could be involved in during the period 1998 to 2006. Although the methodology has many benefits, possibly the biggest may be its ability to estimate the distribution of the occurrence of simultaneous SSC operations. These estimates can be use to evaluate the risk associated with unit availability based on a given resourced force structure, as well as the development of requirements in the force structure development process. The methodology is described and results shown.

Southwest Asia Low Resolution Scenario (SW LRS) 7.0

MAJ Charles E. Davis, Operations Research Analyst
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Ft Leavenworth, KS 66027-2345
The TRADOC Analysis Center (TRAC) bases the SWA LRS 7.0 on the Defense Planning Guidance (DPG) and the SWA Theater Resolution Scenario (TRS) 2.0 also developed by TRAC. SWA LRS 7.0 assumes United States forces are involved in the second of two major theater war (MTW). The scenario is a joint defensive operation employing forces and doctrine based on Army of Excellence force structure and current day doctrine. The force year is 2006 for Blue and 2011 for Red forces.

Once of the objectives of the is to provide a realistic and reusable tool that can be used to examine joint deep strike and maneuver warfare. the scenario incorporates deep strike, interdiction, close air support, SEAD, theater air defense as provide by naval and ground forces, amphibious operations, maneuver warfare, surveillance, reconnaissance, joint communications, support operations and coalition forces in order to analyze our capabilities in defeating threats. This scenario provides a tool for analyzing numbers capabilities in a joint context.

Northeast Asia Low Resolution Scenario (LEA LRS) 3.0

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The NEA LRS 3.0 is based on the Defense Planning Guidance (DPG) and the NEA theater Resolution Scenario 3.0 developed by the TRADOC Analysis Center (TRAC). NEA LRS 3.0 assumes United States forces are involved in a single major theater war (MTW). The scenario is a joint offensive operation employing forces and doctrine based on Joint Vision 2010 concepts. The force year is 2015 for both the threat and Blue forces.

One of the objectives of the scenario is to provide a realistic and reusable tool that can be used to examine the joint operational battle space (JOBS) areas outlined in Joint Vision 2010 and the respective service 2010 vision statements. the scenario focuses on five battle space domains: space, the electromagnetic spectrum, air, sea and land.

Tuesday, 1330 -1500 Working Group 12, Session 2
Heuristic Military Analysis

MAJ Jon J. Peterson, Combat Operations Analyst
TRADOC Analysis Center
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Ft Leavenworth, KS 66027

Heuristic Military Analysis, executed through analysts and Subject Matter Experts (SMEs), can be used to provide credible, accurate analysis when faced with predominantly qualitative data. During the Force XXI Division Advanced Warfighting Experiment, (DAWE) one of the key products desired was an insight on how the modern systems and Force XXI employment concepts facilitated or otherwise affected the somewhat intangible entity of Battle Command. Heuristic Military Analysis, as an exploratory problem solving technique, was used to investigate selected operations conducted during the DAWE to identify and highlight demonstrated and potential Force XXI capabilities. The methodology included collecting data and insights from the Battle Command Training Program (BCTP) observers, system SMEs, Player unit, and analysis team members to develop a comprehensive understanding of the events within those operations. From this understanding, challenges capabilities, and potential to execute missions through the Force XXI Patterns of Operations were identified. These challenges, capabilities and potential capabilities, were then translated into DTLOMS implications. Heuristic analysis of the qualitative data provided by the Subject Matter Experts as described produced insights on the ability of the commander to wield these systems and concepts, and suggests areas for future refinement.

The JWARS Battlespace Entity, An Example of a Computer Generated Forces Structure Addressing Varying Levels of Aggregation

Mr. Denis T. Clements, Project Manager and Mr. Michael A. Goshorn, Lead Software Engineer
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The Joint Warfare System (JWARS) is a modeling and simulation application being developed by the Office of the Secretary of Defense. JWARS is being developed as a state-of-the-art, constructive simulation providing multi-sided and balanced representation of joint theater warfare. JWARS will assist the implementation of Joint Vision 2010 by providing a vehicle to assess current and future military capabilities within the four emerging operational concepts: dominant maneuver, precision engagement, focused logistics, and full-dimensional protection.

To meet these requirements, JWARS requires the development of computer generated forces across the four US services plus coalition, neutral, and threat forces. The level of resolution of the forces to be simulated is an ongoing point of discussion, design, and development. However, the JWARS Development Team has capitalized on the JWARS prototyping experience to evolve what is not called a JWARS Battlespace Entity (BSE).

The BSE is realized in both software structure and a related data structure. Moreover, the BSE may be used to represent more than forces. The BSE is now designed to enable the simulation of operational headquarters, operational forces, assets of operational forces, and installations. Operational headquarters include the JTF Headquarters and the Component Headquarters (Joint Force Air Land Component Command, and Joint Force Special Operations Component). Operational forces down to resolution unit level include ground maneuver brigades, air mission elements (one or more identically configured aircraft), and ship. Assets of operational forces are modeled on an exception basis only, examples may include ballistic missile transport-erector-launchers and individual aircraft. Installations include major transportation nodes as well as operational airbases and tactical assembly areas.

A Generic Parameterized Model of Active Protection Systems for Military Vehicles

Mr. John D. Pinder, Doctoral Fellow, RAND Graduate School
Doctoral Fellow, RAND Graduate School, RAND, 1700 Main Street, PO Box 2138, Santa Monica, CA 90407-2138

Survivability is an important characteristic of military vehicles, since they are required to operate in hostile environments where they may be subject to enemy attacks. One approach to increasing the survivability of a vehicle is to improve its offensive capabilities, so that it can eliminate potential enemy threats prior to an attack. The alternative is to provide the vehicle with the ability to defend itself. The defensive techniques used to protect military vehicles have evolved over time as weapons were designed to overcome existing defenses. Traditional camouflage, concealment and deception (CCD) techniques aimed at avoiding detection have improved gradually and been augmented by ever more advanced passive and reactive armor. In the case of tanks, heavy reliance has been placed on increasingly sophisticated armor to enable

the vehicle to absorb and survive attacks by specially-designed anti-tank weapons. This extra armor has, however, greatly increased vehicle weight, and in turn made it costly and difficult to rapidly deploy armored forces to where they are needed. Active protection systems (APS), which detect and respond automatically to incoming weapons, began to emerge in the 1980Æs. Several such systems are currently operational, and a variety of new and improved APS technologies and concepts are now under development in the U.S. and abroad. If the systems that emerge are sufficiently effective, robust, and light-weight then APS will provide an attractive alternative to thicker, or more sophisticated armor. This trade off would enable the deployability of future vehicles to be improved without sacrificing survivability, and make some type of integrated APS a standard feature on most future military vehicles.

This presentation begins with a brief overview of military vehicle defense in general, and active defense in particular. The conceptual framework presented at the outset illustrates how sensors and countermeasures are integrated in an APS. A classification scheme is then developed and used, along with some other important considerations, to evaluate several existing APS concepts.
The insights gleaned from this examination of current APS concepts was used to design a parameterized model of a generic APS, which was then implemented in a force-on-force simulation (JANUS). This model is described briefly, and then applied to a few illustrative examples. The presentation concludes with a discussion of the results and findings of a preliminary analysis of the performance and military utility of APS within the context of an Army After Next scenario.

Wednesday, 0830 – 1000

COMPOSITE GROUP C SESSION..Room G-109

Wednesday, 1030 - 1200 - Working Group 12, Session 4

Warfighting Analysis in a Ruck Sack (WARS)

Wm. Forrest Crain, Colonel, Chief of Operational Capabilities Assessments, and David E. Bassett, Major, Senior Operations Research Analyst
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The US Army Concepts Analysis Agency has developed a warfighting analytical support team which has demonstrated the capability to provide a deployable, responsive, real time warfighting campaign analysis to the theater level commander in the field. This significant accomplishment is the result of combining several advancements in operations research techniques, decision analysis methods, state-of-the-art hardware and software developments packages. Utilized by US Central Command (CENTCOM) and US Army CENTCOM (ARCENT), WARS has been employed to conduct course of action assessments, determine force allocation and requirements, develop war plans and serve as an exercise 'driver.' During Desert Storm, such analysis was conducted using a mainframe and typically required 5 days to complete a course of action assessment. WARS enables the same task to be accomplished in 2-3 hours to include production of decision maker quality products. Lieutenant General (Retired) Steve Arnold, former Commander of ARCENT, describes WARS as "....truly revolutionary, significant and influential..." and "...this capability could and should soon be proliferated to corps and divisions." Clearly, WARS is an analytical quantum leap forward in leveraging today's technology and portends how technology can assist the theater level warfighting commander's campaign decision making.

Breaking the Phalanx (BTP) Analysis

Wm. Forrest Crain, Colonel, Chief of Operational Capabilities Assessments
Steve Orloff, LTC, Senior Operations Research Analyst
U.S. Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

The BTP Analysis was conducted at the request of the Chief of Staff of the Army, and is an examination of the organizational, modernization and doctrinal initiatives for the Army proposed by COL Doug MacGregor in his book *Breaking the Phalanx.*

The analysis departs from the standard "cold war attrition modeling" paradigm and examines the initiatives in light of the physical, mental and moral domains of war in a Southwest Asia MTW scenario. The contribution of each initiative, as well as in combination with the other initiatives, is considered to identify any synergistic benefit which might be realized. The organizational initiative considers the current US Army division structure versus that of brigade sized groups. The modernization initiative considers the Force XXI capabilities versus those programmed for the 2005 time frame. The doctrinal initiative examines current warfighting doctrine versus one which is designed to capitalize on the Force XXI capabilities (described in TRADOC Pam 525-5).

The results provide interesting insights into which of these initiatives provide the most significant benefit to the warfight and which ones, in combination, offer the greatest potential to force effectiveness. Of particular interest in this analysis is how the capability of information dominance and situational awareness were introduced into the simulation.

Grizzly Requirements Analysis

CPT John Keeter, Military Combat Analyst and Patrick G. Smock, Senior Operations Research Analysis
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The Grizzly system is a new-development vehicle designed to conduct in-stride breaching of complex obstacles.

The Grizzly Requirements Analysis was recently conducted for the Army Staff by the TRADOC Analysis Center. The purpose of the analysis was to identify the appropriate organizational and operational concept for the Grizzly system, and to determine a preferred

distribution plan for the system.

This paper will discuss results from high-resolution modeling and simulation of task force breaching operations, and MAPEX analysis of a multiple theater-of-war ground campaign.

Wednesday, 1330 - 1500 Working Group 12, Session 5

Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP) Requirements Analysis

Mr. Patrick G. Smock, MAJ John M. Harwig
TRADOC Analysis Center
Attn: ATRC-SAA
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Grenadier Beyond-line-of-sight Reporting and Targeting (BRAT) device is a small, lightweight, manportable transceiver that receives location information from Global Positioning System satellite broadcasts and transmits unit identification, location, and other desired brevity coded messages to higher headquarters' command and control systems. Signals are relayed from Grenadier BRAT devices through existing satellite, aircraft, unattended aerial vehicle, aerostat, or tower systems.

The Grenadier BRAT Warfighting Rapid Acquisition Program Requirements Analysis was commissioned by the Battle Command Battle Laboratory - Ft Leavenworth in may 1997. The objectives of the analysis included:

- Determine Grenadier BRAT system-level capabilities and limitations, including capabilities of existing communications relay systems to process additional transmissions for Grenadier BRAT-equipped units.
- Evaluate the potential value of Grenadier BRAT;s contribution to Army deep force situational awareness, with emphasis on corps-sized forces in multiple warfighting scenarios.
- Based on the previous evaluation, develop preferred quantities of systems for distribution within the Army force structure.

To meet the objectives of this study, TRAC and BCBL conducted a MAPEX to examine two approved operational scenarios based on TRADOC's Division Design Analysis.

Candidate distribution plans were developed for each scenario and evaluated in the MAPEX in order to develop recommended preferred distribution of systems. This paper documents the results of the study effort.

JWARS - Attrition

MAJ Paul J. Warhola, JWARS USMC Representative
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Arlington, VA 22209

One brushstroke in the art of war is the destruction of the enemy's personnel, equipment and installations. A significant challenge to the Joint Warfare System (JWARS) development process is to appropriately represent attrition across all systems and environments within the specified runtime constraints. Algorithms span one-on-one engagements, such as anti-ship missile versus aircraft carrier, to highly aggregated brigade versus brigade battles. the final simulation will incorporate existing methods, improvements to the existing and some original approaches. this presentation will discuss algorithms, other appropriate design materials identified to date and outstanding issues.

Marine Corps Analytic Modeling and Simulation

LTCOL William A. Sawyers, Studies and Analysis Division
MCCDC
3300 Russell Rd.
Quantico, VA 22134-5130

The Marine Corps has instituted a new Mission Area Analysis (MAA) process to identify operational requirements and deficiencies. In the past, the MAA process was subjective and somewhat lacking in analytic rigor. The new methodology extensively employs the capabilities of models and simulations to provide quantifiable findings as the basis for the marine Corps Combat Development Process. Prior to this effort, the one-site analytic modeling capability of the Marine Corps Development Command (MCCDC) was limited. The newly formed MAA Branch conducted a survey of existing and developing simulations, and produced a plan to rapidly expand MCCDC's analytic tool set. An initial suite of models were selected and installed to provide insight across the functional areas of maneuver, fires, C4, ISR, logistics, and force protection. the very nature of Marine Expeditionary Operations across the domains of land, sea, and air added to the complexity of the task. This paper will discuss the evolving analytic modeling capabilities of the Marine Corps.

Thursday, 0830 - 1000 Joint Session with Working Group 11/12

Joint Session with WG 11 & 12 .... Room G-102

Representing Ground Vehicle Mobility in Virtual Environments with Relevance to Materiel Development and Tactical Trainers

Dr. Niki Deliman
Geotechnical Laboratory
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Virtual Environments are being increasingly utilized by the military to conduct vehicle assessments and training with ground vehicles.

While off-road vehicle mobility modeling for military analysis has traditionally concerned steady-state, maximum achievable vehicle speed attainable over relatively large , nominally homogeneous areas, advancing applications in Virtual Environments require higher-resolution representation of soil-traction element interaction. The vehicle-soil/surface response must be realistic at higher-resolution scales for effective use and analysis with or without the human-in-the-loop. The U.S. Army Engineer Waterways Experiment Station (WES) has recently developed a baseline physics-based capability to model soil-traction element interaction at less-than-maximum potential for higher-resolution scales. The research objectives involved developing a soil response model to characterize load-motion resistance-sinking relationships, linking soil response and vehicle dynamics algorithms, and evaluating results via field experiments. Selection of mobility factors and spatial resolution were considered. Model methodology and results will be presented with an emphasis on advancing mobility representation in Virtual Environments.

The JCATS Terrain Model and Its Effects on Conflict Simulation

Mr. Gary Friedman
Conflict Simulation Laboratory
Lawrence Livermore National Laboratory

The Joint Conflict and Tactical Simulation (JCATS) is the latest conflict simulation to be developed at the Lawrence Livermore National Laboratory (LLNL). JCATS is a multi-sided, interactive, entity-level simulation utilized by military and site security organizations. It is used as an exercise driver and tool for training, analysis, and mission planning. The primary sponsor of JCATS is the Joint WarFighting Center (JWFC). Users of JCATS simulation include US Army, Air Force Security Forces, US Special Operations Command, US Marine Corps, US Southern Command, US Army Europe, Department of Energy, and US Secret Service.

JCATS merges the capabilities of two other LLNL developed simulations, the Joint Tactical Simulation (JTS) and the Joint Conflict Model (JCM). It provides a rich environment of integrated capabilities that are used for the simulation of combat, security exercises, and Operations Other Than War. Among the capabilities provided by JCATS are detailed modeling of rural and urban terrain, dynamic aggregation and de-aggregation of entities, lethal and non-lethal effects of munitions, and day and night operations. Entities that can be modeled include group forces, fixed wing aircraft, helicopters, and water craft.

The element that ties together all the other elements of a simulation is the playbox terrain. JCATS usage ranges from small exercises utilizing a handful of entities in a one square kilometer playbox, up to large division-level exercises utilizing thousands of entities and aggregates on a 1000 square kilometer playbox. An extensive set of terrain features is utilized by JCATS in its adjudication of combat. The terrain model includes terrain elevation, vegetation, pavement, lakes, rivers, buildings, doors, walls, windows, area and spot lights, fences, and unattended sensors. A handful of dynamic terrain objects such as foxholes and barriers are also simulated in the JCATS environment. The assessment of movement, acquisition, shooting effects, and all other aspects of simulated combat are all affected by the terrain model in JCATS. This presentation wil provide a general discussion of the terrain model in JCATS and how it is used to give a realistic portrayal of combat and peace keeping operations.

The JCATS Lighting Model and Its Impact on Simulated Conflict

Mr. Thomas Kelleher
Conflict Simulation Laboratory
Lawrence Livermore National Laboratory

Approved abstract not available at printing.

Transportation Infrastructure Assessment

Dr. David Horner, Dr. William Willoughby, and Dr. Niki Deliman
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US Army Waterways Experiment Station
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Vicksburg, MS 39180-6199

The Transportation Infrastructure Assessment Module (TIAM) is being developed by the US Army Engineer Waterways Experiment Station as the prototype general engineering component of the Engineer Operations System (E-OPS) with a specific focus on the engineer interface with logistics and transportation operations. The TIAM is designed as a decision support tool to be used by the engineer in analyzing road networks during planning for initial usage and maintenance and rebuild phases for the transportation network. Support for military sustainment engineering operation within an operational theater are provided by the following capabilities in TIAM: evaluation of the impact of environmental factors on the maximum throughput along selected routes, identification of potential logistics support areas, estimation of road life based on expected or actual traffic flow, analysis of engineer work effort required to maintain and repair roadways. The purpose of this presentation is to discuss TIAM functions and applications.

<u>Thursday, 1030 - 1200 Working Group 12, Session 7</u>
Investigation of the Effects of Active Protection Systems (APS) on Tactical Missile Systems

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PEO Tactical Missiles
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Redstone Arsenal, AL 35898-8000

Mr. Marvin S. Smith
Nichols Research Corp.
4040 Memorial Parkway SW
Huntsville, AL 35895

The paper will provide the results of a parametric investigation of the effect of some active protection systems (APS) on various tactical missile systems. This investigation is under the direction of PEO Tactical Missiles located at Redstone Arsenal, AL.

The primary objective of this investigation is to determine the effects of various attributes of APS on tactical missile systems. These attributes included the degree of APS coverage or protection, the probability of APS defeating an incoming missile and the number of APS munitions on board. The effects of PS on any particular tactical missile systems are not considered in isolation. The operational effects of APS on various tactical missile systems (e.g., Hellfire, TOW2B, Javelin, etc.) are considered in conjunction with other systems in the force. A secondary objective of this investigation is a detailed review of the tactics and data used to represent the APS and the tactical missile systems.

The effects of APS are assessed through the use of the battalion/brigade level combat simulation CASTFOREM in several high resolution scenarios.

Course of Action Analysis for Military Decision-Making

Dr. Robert S. Alexander, Science Applications International Corporation (SAIC)

Approved abstract unavailable at printing.

Rapid, Flexible Deployment Planning Techniques Using the Strategic Lift Integrated Model

Jerry Butler
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1700 North Moore Street, Suite 1850
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Military operations in the 21st Century will be characterized by increased deployments, rapidly changing missions and situations, and high degree of uncertainty. Operations planners and analysts will require fast and flexible planning tools in the face of fuzzy environments and many constraints. OPLANS have been developed for many contingencies using large detailed models. However, the potential for troop and lift resource commitments to other operations/contingencies or for countries to restrict the flow of US forces (overflight, use of airports/seaports or facilities, etc.) makes the operations planner/analyst's challenge much more complex and may make those plans unexecutable.

The Strategic Lift Integrated Model (SLIM) was designed to model time phased flow of tailored force packages to a theater of operations in support of campaign analysis and provide deployment input to other models. SLIM simulates the air and sealift of forces from numerous locations simultaneously while dynamically allocating lift resources and simulating numerous constraints that can vary with combat intensity. It provides accurate closure times for each element of the Joint Task Force throughout the campaign. SLIM, using a personal computer, provides for a comprehensive analysis of strategic lift allowing for rapid change of constraining parameters.

Planners must quickly assess the feasibility of deployment plans, assess the utility of TPFDDs when time and transportation resources are limited. Planners need a capability to conduct "What-if drills" to changes in deployment plans if air or seaports suddenly become unavailable or experience reduction in throughput capacity.

This presentation will focus on the utility of tools like SLIM for rapid and flexible mobility operations planning for emergency deployments and other contingency operations.

Thursday, 1330 - 1500 Working Group 12 Session 8
Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling

Alan D. Zimm, Senior Professional Staff, Johns Hopkins University Applied Physics Laboratory

Most current models of combat are based on an attrition warfare paradigm, where destruction of enemy forces and material are the objectives. However, models based on attrition warfare approaches do not reflect the actual combat processes that lead to victory. The current US Marine Corps doctrine of Maneuver Warfare recognizes that the path to victory lies in more than destruction of material - for example, Marine Corps Doctrine publication -1, "Warfighting," ways that "the results of maneuver are both physical and morale. the object of maneuver is to shatter the enemy's cohesion, organization, command, and psychological balance." Clearly, any model that does not incorporate "cohesion, organization, command, and psychological balance" cannot reflect the relative strengths and weaknesses of Maneuver Warfare.

A serious handicap has been the lack of a conceptual model of Maneuver Warfare on a level that could be incorporated into computer simulations.

This presentation outlines a conceptual model of Maneuver Warfare. The scope of the model runs from non-combat "deterrence" operations through combat in major wars. It incorporates defining and modeling the sources of victory, incorporates human factors such as morale, cohesion, and fighting spirit, and creates a conceptual model of the degradation of command processes when under stress. The objective is to provide a common taxonomy, define interrelationships, and serve as a springboard towards a more detailed algorithmic-level development of a model of Maneuver Warfare.

Quantifying The Value of Manned Reconnaissance in the Simulation of Land Warfare

Dr Ephraim Martin IV
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Dr Michael Proctor
UCF PO Box 162450
Orlando, FL 32816

Successful manned reconnaissance is the key to land warfare victory. This fact is borne out in unit performance at the National Training Center but has proven difficult to quantify in land combat simulations. Good manned reconnaissance reveals the enemy's intent inside the enemy's decision cycle allowing disruption of the enemy plan with massing of fires and forces at the critical time and place to achieve a decisive victory. Manned reconnaissance forces provide the commander unique and critical information about the enemy. Manned recce can loiter and observe the enemy interactively over time in detail, and unobserved. This persistent quality acquisition allows manned recce to

determine threat intent thus providing a critical dimension to the intelligence picture which other assets cannot provide.

Traditional models measures of intelligence such as rate of enemy detection, recognition and, identification seek to capture the value added to a force. These measures are typically not highly correlated to loss exchange ratio. This fact makes justification of improved manned reconnaissance assets difficult. This research proposes and explores an extension of traditional metrics by demonstrating a measure of reconnaissance performance called intent. Intent is related to the concept of reducing situational entropy or uncertainty in a tactical situation. Specifically as reconnaissance assets observe the threat in detail over time and report this information to the commander, the commander can construct a clearer picture of threat intentions and revise the tactical plan to more efficiently defeat the threat.

Intent emphasizes four elements of intelligence: detailed identification, persistent observation, timeliness of reporting and, percent of threat force identified and observed over time. With such information it is assumed that the commander can determine the intent of the threat force. Once intent is established the tactical plan can be changed to counter the threat plan more efficiently.

2 MTW 2010 Defense Planning Guidance Baseline Study

Major Robert A. Morris, Campaign Analyst
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Washington, DC 20330-1570

This study examines the USAF's ability to support the National Military Strategy to fight and win two Nearly simultaneous Major Theater Wars (MTW). The results update the previous 2 MTW studies based on changes in the FY 1998-2003 Defense Planning Guidance and the AF Program Objective Memorandum (POM).

Measures of merit were primarily based on those determined during the baseline 2003 study. they include: FLOT movement, air and ground attrition, munitions expenditure and sortie data. Planned advances in information superiority, weapon effectiveness and sortie rates were all examined.

AIR POWER significantly contributes to sinning the war by early HALT of advancing enemies, and attriting those forces in advance of a ground action. This Air Offensive is a key enabler of the total campaign effectiveness and significantly broadens the scope of options for the NCA and JFC.

WG 13 - LITTORAL WARFARE AND REGIONAL SEA CONTROL

Chair: Dr. Steve Pilnick, Global Associates, Ltd.
Cochair: CDR Steve Phillips, CNO N813
Cochair: LCDR Bob Kallio, CNO N815
Cochair: Prof. Carlos Borges, Naval Postgraduate School
Cochair: Paul Cassiman, Kapos Assoc., Inc.
Room: G-110

Tuesday, 1030-1200 (Working Group Session # 1)
WG-13: MINES, TORPEDOES, & MARITIME PREPOSITIONING
The Future of Naval Mines
A.I. Kaufman, W.J. Hurley, W.L. Greer, RADM B.C. McCaffree, USN (Ret.), RADM J.D. Pearson, USN (Ret.), Mrs. Sabrina Edlow, Institute For Defense Analyses

An Evaluation of Shallow Water Heavyweight Torpedo Effectiveness 1994-1997
Dr. Steven A. Rabinowitz, Institute For Defense Analyses

Mission Area Analysis for MPF 2010/Seabasing
Dr. Jack Nance, Center for Naval Analyses

Tuesday, 1330-1500 (Working Group Session # 2)
Joint Session with WG 13 & 14 .... Room G-102

Wednesday, 0830 – 1000
COMPOSITE GROUP C SESSION .... Room G-109

Wednesday, 1030 - 1200
COMPOSITE GROUP C SESSION .... Room G-109

Wednesday, 1330-1500 (Working Group Session # 5)
Joint Session with WG 13 & 14 .... Room G-109

Thursday, 0830-1000 (Working Group Session # 6)
Joint Session with WG 13 & 14 .... Room G-109

Thursday, 1030-1200 (Working Group Session # 7)
WG-13: MINE COUNTERMEASURES
Operational Maneuver from the Sea Simulation
Joseph Manzo, The MITRE Corporation

Airborne Mine Neutralization System Analysis Of Alternatives
John Benedict, Johns Hopkins University Applied Physics Laboratory and Kenneth J. Montgomery, Naval Surface Warfare Center, Carderock Division

Thursday, 1330-1500 (Working Group Session # 8)
WG-13: C4ISR, TBMD, & SUPPRESSION OF ENEMY COASTAL DEFENSE

Modeling C4ISR at the Joint Campaign Level Warfight
LTC James A. Knowles, Ph.D, Defense Information System Agency

High Frequency Surface Wave Radar for Low Altitude and TBM Detection
Dr. Joe Frank, Dr. John Richards, E. Chun, Johns Hopkins University Applied Physics Laboratory, and Dr. Robert Dinger, SPAWAR Systems Center, San Diego

Joint Suppression of Enemy Coastal Defense
Dr. Steven E. Pilnick, Global Associates, Ltd.

WG 13 - LITTORAL WARFARE AND REGIONAL SEA CONTROL
Room: G-110

Tuesday, 1030-1200 *(Working Group Session # 1)*
WG-13: MINES, TORPEDOES, & MARITIME PREPOSITIONING

The Future of U.S. Naval Mines

A.I. Kaufman, W.J. Hurley, W.L. Greer, RADM B.C. McCaffree, USN (Ret.), RADM J.D. Pearson, USN (Ret.), Mrs. Sabrina Edlow

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Naval mine warfare is composed of mine countermeasures (MCM) and naval mining. While significant improvements are being made to the Navy's MCM capability, there are clear indications that the nation's naval mining capability is waning as the 21st century approaches. This White Paper reports on the deliberations of a panel of individuals who have at some previous time held highly responsible positions in the government of the United States: The Honorable Richard Cheney, Dr. Richard L. Garvin, The Honorable John O. Marsh, Jr., The Honorable Robert C. McFarlane, Rear Admiral John M. Poindexter, USN (Ret.), Professor David Rosenberg, General William Y. Smith, USAF (Ret.), Admiral Carlisle A.H. Trost, USN (Ret.), The Honorable Paul Wolfowitz, The Honorable R. James Woolsey, and Admiral Ronald J. Zlatoper, USN (Ret.). This senior panel sat to consider the question of whether the United States ought to develop and maintain a modern naval mining capability.

At the end of the day, the panel concluded that the United States Navy should stay in the business of naval mining. The panel recommended that R&D and acquisition programs, not to exceed $30M a year, be initiated to undertake the process of creating a flexible and affordable stockpile of naval mines.

An Evaluation of Shallow Water Heavyweight Torpedo Effectiveness 1994 -1997

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In the early 1990's, the Mk 48 Advanced Capability (ADCAP) torpedo program shifted emphasis from the Cold War threat to emerging littoral scenarios. That reorientation entailed addressing quiet diesel-electric threat submarines operating in the shallow water environment. The ADCAP program has undertaken a series of upgrades designed to improve shallow water torpedo effectiveness and at each stage IDA, in support of OSD's Director, Operational Test and Evaluation, has been actively involved in operational test planning and monitoring and subsequent data analyses. Shallow water testing represents a departure from previous torpedo exercises, and the test program has required innovative approaches to target emulation, site selection, scenario design, and tactical development. This paper covers three major operational tests. The testing of near-term tactical software upgrades was conducted in 1994. Operational testing in 1995 concerned a torpedo propulsion hardware upgrade designed to enhance torpedo effectiveness. Finally, in 1997, a further upgrade of the tactical software was evaluated. In all three cases, IDA analyses relied heavily upon comparisons between the baseline weapon and the upgrade in order to measure the relative improvements. We also developed new measures of performance and effectiveness to address specific issues and employed desktop modeling and simulation where appropriate.

Mission Area Analysis for MPF 2010/Seabasing

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CNO (N42/N85) asked CNA to conduct a mission area analysis of the seabasing concept for the Maritime Prepositioning Force 2010 (MPF2010) and beyond. The objective is to develop material options and costs that meet the Marine Corps' seabasing requirements.

The goal of MPF 2010 is to provide a seabase from which combat-ready Marines can be deployed and sustained thereby eliminating the need for host nation support facilities. The MPF 2010 ships will require capabilities that are not in the current ships, like accommodations for embarked Marines, assembly and staging areas, and facilities for command and control. Such a seabase permits Marines that deploy via the ships of an MPSRON to participate in OMFTS and STOM. The forces ashore will be resupplied from the seabase, and the seabase will be replenished by Navy combat logistics ships or commercial ships.

Our approach to this study was to first bound a wide-ranging set of requirements. We translated the requirements into technical descriptions and identified the key cost drivers. We then developed capability options that covered the range of capabilities from the lower to the upper bound. For each capability option, we developed a corresponding operational concept. We developed conceptual designs for the ships needed to make the MPSRON for each capability option. We developed measures of effectiveness, including acquisition and life-cycle costs, and applied them to the options.

We found that the MPF 2010 seabasing concept is achievable and that any amount of seabasing offers a substantial operational enhancement over the current MPF.

Wednesday, 0830 – 1000
COMPOSITE GROUP C SESSION...Room G-109

Wednesday, 1030 - 1200
COMPOSITE GROUP C SESSION...Room G-109

Wednesday, 1330-1500 (Working Group Session # 5)
Joint Session with WG 13 & 14...Room G-109

Thursday, 0830-1000 (Working Group Session # 6)
Joint Session with WG 13 & 14...Room G-109

Thursday, 1030-1200 (Working Group Session # 7)
WG-13: MINE COUNTERMEASURES
Operational Maneuver from the Sea Simulation

Joseph Manzo
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The Joint Countermine Operational Simulation (JCOS) is an advanced distributed simulation developed under the Joint Countermine Advanced Concept Technology Demonstration (ACTD). The JCOS objective is to support training, planning, and analysis of joint operations in the littorals. An essential program element is to support the assessment of military utility of a family of Army, Navy and Marine Corps countermine systems in realistic operational scenarios. JCOS will be employed by the ACTD in the June 1998 Canadian/U.S. exercise MARCOT/Unified Spirit.

JCOS utilizes, as it's primary simulation components, the semi-automated forces (SAF) applications developed under DARPA's Synthetic Theater of War (STOW) program, which when used together allow the user to construct a seamless simulation of joint operations from sea to land. The JCOS developed and integrated mine and countermine objects in STOW.

JCOS also employs three critical tools to provide an end to end system. The JCOS exercise management and control system allows the user to more easily configure hardware and software components and reproduce the design for repeatability in subsequent experimental trials. The C4I Gateway component generates standard military messages from simulation data and can stimulate service command and control systems. The after action review system (AARS) empowers the user to extract detailed unit, task, and system performance metrics from the simulation results. The AARS uses web-based technology to provide a platform independent assessment environment.

Taken as a complete system, JCOS provides a unique capability for developing and evaluating new concepts, tactics, and doctrine for conducting operational maneuver from the sea.

Airborne Mine Neutralization System Analysis Of Alternatives

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To sustain the Navy's operation in the littoral and vital sea lanes of communication, Naval Forces must possess the ability to conduct mine countermeasures (MCM) to detect, localize, and neutralize the sea mine threat without impeding the speed of advance of the battle group. An Airborne Mine Neutralization System (AMNS) will provide future fleet helicopters with a rapid response MCM capability to safely and efficiently neutralize mines in limited regions where mine avoidance is not expedient or possible. An Analysis of alternatives (AOA) was performed by the Navy to validate the operational need for AMNS and to independently assess the cost/effectiveness of alternative approaches for expendable, naval helicopter delivered, remotely operated, mine neutralization devices (MND). General issues that were investigated include: What level of clearance is achievable within time periods defined for various operational settings? What is the relative cost and effectiveness of various design trades? What are the key cost drivers? What are the key performance/effectiveness measures (threshold/objectives) that should guide the AMNS Program? What upgrades to AMNS would allow a "fire & forget" MND ?

Thursday, 1330-1500 (Working Group Session # 8)
WG-13: C4ISR, TBMD, & SUPPRESSION OF ENEMY COASTAL DEFENSE
Modeling C4ISR at the Joint Campaign Level Warfight

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In June of 1995, the Defense Information System Agency (DISA) developed a Joint Command, Control, Communication, and Computer (C4) Intelligence, Surveillance, and Reconnaissance (ISR) federation using the Defense Modeling and Simulation Office (DMSO) High Level Architecture (HLA). The federation, appropriately called the C4ISR Model, is a new tool used in analysis to demonstrate the added value of information within a Common Operational Picture (COP) and the subsequent affect on decision making. In the Fall of 1997, the model began it's first analytical use supporting the Joint Staff (J6I) and the C4 Integration Support Activity Decision Support Center (DSC) in the Sensor-to-Shooter Joint Fire Support: Close Air Support

Study by examining the volumetrics associated with two different C4 architectures. Expanding on the Joint Fire Support Study, the C4ISR Model supported the Joint C4 Battle Management Study by assessing the impact of different C4 Architectures have on the development of mass effects prior to the execution phase of a planned theater scheme of maneuver. In addition to supporting the J6 and DSC, the Naval Surface Warfare Center - Dahlgren used the model to demonstrate the added value of C4 supporting Theater Ballistic Missile Defense (TBMD) operations as defined by the four pillars of TBMD: Active Operations, Passive Operations, Attack Operations and Battle Management, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (BMC4ISR). This presentation will cover a description of the C4ISR Model, the process used to support a C4 study plan and finally, it will highlight of the results from the supported studies.

High Frequency Surface Wave Radar for Low Altitude and TBM Detection

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The US Navy has had in place an Advanced Technology Development since 1994 to provide a High Frequency Surface Wave Radar for deployment on naval vessels. The primary purpose is to provide Over-The-Horizon detection of low flying targets. Also of interest is the capability to detect TBM's at ranges of several hundreds of kilometers. By using the surface wave mode, the system is designed to detect small low flying missiles at ranges well beyond that for a microwave radar. This allows additional alertment time for cueing fire control radars and for the deployment of countermeasures prior to the acquisition of own ship by the missile.

The same radar can operate in a line of sight mode, above the horizon, to detect TBM's. By exploiting the enhanced RCS of the missile as it rises shortly after burnout, the radar is predicted to detect missiles at hundreds of kilometers .Recently, an experimental HF radar participated in DUNDEE (Down Under Early Warning Experiment) a joint Australian-US project conducted in northwestern Australia. These measurements against TBM surrogate targets confirmed the detection predictions. Results of the Project DUNDEE experiments will be presented.

Kalman filtering techniques have been used to predict the position of the TBM after it passes above the vertical coverage of the antenna so that a fire contol radar can be cued. Similar techniques have been used to predict the launch point of the missile. These results will also be presented .

Joint Suppression of Enemy Coastal Defense

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Enemy coastal defense can severely impact friendly force operations and tempo by denying use of maritime chokepoints, such as the Strait of Hormuz; preventing a strategic coastal objective, such as amphibious landings at Normandy or Inchon; or restricting use of an offshore operating area, such as the Arabian Gulf.

Based on insights gained through a joint analytical wargaming process, this presentation reports on the conceptualization of a doctrine of Joint Suppression of Enemy Coastal Defense (SECD) to enable joint military operations in the littoral, which might otherwise be denied, or limited in effectiveness, or subjected to an unacceptable level of friendly force losses because of enemy use of coastal defensive systems. We define SECD as that activity which neutralizes, destroys or temporarily degrades enemy coastal defense by destructive and/or disruptive means. We introduce the concept of *phased multi-dimensional coordination.* In SECD, phased refers to the use of time sequencing of friendly force capabilities to counter enemy use of overlapping defensive layers. Multi-dimensional refers to air, land, and sea dimensions of enemy coastal defense and friendly forces used to suppress them. Coordination refers to the enhancement of SECD actions due to enabling effects and mutual support.

CVX Requirements Generation

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The Next Generation Aircraft Carrier (CVX) Program was faced with supporting the generation of an Operational Requirements Document (ORD) on an accelerated schedule of approximately one year. In order to comply with DoD guidance to use Cost as an Independent variable (CAIV) and the desires of the program sponsor to involve the user community in the setting of operational requirements, a ORD generation plan was developed to meet this schedule. The major points of this plan included the description of the CVX in terms of quantifiable attributes, interaction with fleet users to determine their ranking of these attributes, an analysis plan to evaluate the contribution of these attributes to overall CVX effectiveness, a modeling and simulation plan to generate the effectiveness values, and a concurrent costing effort to enable the cost-effectiveness trades to be made. This paper will describe this process and its progress to date. Additionally, we will discuss the difficulties of developing a plan that required significant interaction with other major aircraft programs, as a major contribution to the effectiveness analysis is resident in the capabilities of the airwing embarked on CVX. We will also discuss the peculiarities of operations in the littoral battlespace and forecasting of threats for a platform that will enter the fleet in 2013 and have a life span for the class of ships that will reach to approximately 2090.

WG 14 – POWER PROJECTION, PLANNING AND EXECUTION

Chair: Jack Keane, JHU/APL
Advisor: Bruce Powers, Chief of Naval Operations (N816)
Co-chair: Tim Sullivan, Raytheon, TI Systems
Co-chair: Jim Warren, Strategic Insight, Ltd.
Room: G-114

Tuesday, 1030-1200 (Working Group Session # 1)
WG-14: Strike Mission Effectiveness and Asset Employment
Optimizing Selection of Tomahawk Missiles
LT Scott Kuykendall, USN, Professor Richard E. Rosenthal, Naval Postgraduate School

Targeting Geo-coordinates for Battle Group Employment of GPS-Guided Munitions
Dr. Robert W. Ward, Center for Naval Analysis

Analysis and Predictability of the Effectiveness of Navy Platforms When the Number of Assets is Small
Dr. Philippe Loustaunau, Anne Milewich, Wendell Nix, System Planning and Analysis, Inc.

Tuesday, 1330-1500
Joint Session with WG 13 & 14.. Room G-102

Warfare Networks; A Combat Theory
LCDR Jeffrey R. Cares, USN, Chief of Naval Operations Strategic Studies Group

Network Centric Warfare
Dr. Bruce Powers, Chief of Naval Operations (N816)

Wednesday, 0830 – 1000
COMPOSITE GROUP C SESSION... Room G-109

Wednesday, 1030 - 1200
COMPOSITE GROUP C SESSION... Room G-109

Wednesday, 1330-1500 (Working Group Session # 5)
Joint Session with WG 13 & 14.. Room G-109

Information Management & Tactical Displays to Support the Area Air Defense Commander (AADC)
Milton "Mickey" Gussow
The Johns Hopkins University Applied Physics Laboratory

CVX Requirements Generation
Donald R. Bouchoux, John Lillard, Kevin Moore
Whitney, Bradley & Brown, Inc.

Thursday, 0830-1000 (Working Group Session # 6)
Joint Session with WG 13 & 14.. Room G-109

Surface Combatants for the Twenty-First Century
Dr. Matthew J. Vanderhill, MIT Lincoln Laboratory

SC-21 COEA, Part II: Campaign Analysis Results
Ted Smyth, The Johns Hopkins University Applied Physics Laboratory

Thursday, 1030-1200 (Working Group Session # 7)
WG-14: Maneuver Warfare and Campaign Analysis

Modeling Maneuver Warfare: Incorporating Human Factors and Decision-making in Combat Modeling
Alan D. Zimm, The Johns Hopkins University Applied Physics Laboratory

Warfighting Analysis in a Ruck Sack (WARS)
Colonel Wm. Forrest Crain, Major David E. Bassett, US Army Concepts Analysis Agency

Thursday, 1330-1500 (Working Group Session # 8)
WG-14: Advanced Aviation Systems and Mission Effectiveness Analysis
Joint Strike Fighter (JSF) Study
Dr. L. Dean Simmons, Institute for Defense Analyses

Concepts and Technologies for the Future of JSEAD
Damian DiPippa, Coleman Research Corporation

WG 14 – POWER PROJECTION, PLANNING AND EXECUTION
Room: G-114

Tuesday, 1030-1200 (Working Group Session # 1)
WG-14: Strike Mission Effectiveness and Asset Employment
Optimizing Selection of Tomahawk Missiles

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The Tomahawk Land Attack Cruise Missile (TLAM) launched from surface ships and submarines, has become the weapon of choice for the United States in many situations. In an era of high precision, fast delivery weapons, the method currently used for assigning TLAM engagements is out of step with the development of the weapons themselves. The missile assignment process used today is essentially manual, with the potential consequences of inefficient missile-to-mission matching and unnecessary delay.

This thesis develops a new optimizing approach to missile-to-mission matching using integer programming. In a matter of seconds for a single ship or a matter of minutes for a battle group, the optimization model determines which missile to select for each tasking order and provides back-up assignments if requested. The objective of the model is to ensure the best weapon is applied against each target while maximizing the salvo capability of the firing units to perform future taskings.

The new missile-to-mission matching model is better than current methods and performs robustly in extensive sensitivity analysis. The optimization model is currently being considered for shipboard implementation by the Naval Surface Warfare Center. At the very least, the model can be used independently to assess the performance of any new missile-to-mission matching decision support considered by the Navy.

Targeting Geo-Coordinates for Battle Group Employment of GPS-Guided Munitions

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GPS-guided munitions (GGMs) will soon be available in large numbers to Navy Battle Groups. Air-launched GGMs such as JSOW, JDAM, and SLAM-ER will join TLAM Block III, already deployed. A GGM must be programmed before launch with accurate geo-coordinates of the intended target aimpoint. However, it is not clear how target geo-coordinates can be obtained in the fleet environment to support a large-scale strike operation. Fleet Battle Experiment Bravo, conducted by COMTHIRDFLT in late 1997, attempted to answer the following questions:

- Are geo-coordinates that have been mensurated using products of various tactical and national reconnaissance assets accurate enough for GGMs?
- Can geo-coordinates be produced at a large enough rate to support a sustained large-scale joint strike operation?
- Can geo-coordinates be produced responsively enough on demand to meet the time requirements of the air tasking order (ATO) cycle?

Fleet Battle Experiment Bravo featured a network-centric approach to the problem. A JFACC embarked in the Fleet flagship in the western Pacific produced GGM-intensive ATOs by pulling in geo-coordinates being produced by organizations located remotely from the Battle Group. This paper presents an analysis of the results of the experiment, discussing the accuracy, volume, and timeliness of aimpoint geo-coordinate production. Observations are made regarding the existing tactical targeting architecture, bottlenecks in the process, and fixes needed to effectively utilize the planned GGM inventory.

Analysis and Predictability of the Effectiveness of Navy Platforms When the Number of Assets is Small

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A special challenge to analysts is the situation when there are only a small number of Navy platforms available to perform critical mission(s). As political and budget considerations bring the number of Navy inventory assets to record low levels, and as the geopolitical situation may demand a more complex commitment of those assets, it becomes vital for the analyst to rely less on steady-state models and expected values. Instead, one has to develop new approaches based on a detailed analysis of scheduling and operational issues, including stochastic ones, which will accurately predict the effectiveness bounds of those platforms for the intended mission(s).

In this presentation, we will discuss the approach we developed for this problem. In our analysis, we incorporate operational and maintenance constraints to develop an optimal (as a function of mission requirements) designed schedule. That schedule allows us to provide a first set of measures, which we call *Static Measures*: how good the schedule is if executed exactly as specified. We then analyze how robust that schedule is in the face of random perturbations during execution. This provides a second set of measures, which we call *Dynamic Measures*. We consider two types of random perturbations: casualties (e.g., collisions, machine failures, etc.), and smaller deviations (e.g., late departure from port, early arrival, etc.). When the number of platforms gives enough slack to the schedule, these perturbations may have little impact on the planned effectiveness of the force, but when the number of platforms is small, these perturbations impact the planned effectiveness of the force in a significant way and jeopardize the execution of the intended mission(s), or the confidence of doing so in a predictable way.

Tuesday, 1330-1500 (Working Group Session # 2)
Joint Session with WG 13 & 14.. Room G-102

Warfare Networks; A Combat Theory

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Network Centric Warfare

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Wednesday, 0830 – 1000
COMPOSITE GROUP C SESSION.. Room G-109

Wednesday, 1030 - 1200
COMPOSITE GROUP C SESSION.. Room G-109

Wednesday, 1330-1500 (Working Group Session # 5)
Joint Session with WG 13 & 14.. Room G-109

Information Management & Tactical Displays to Support the Area Air Defense Commander (AADC)

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The National Defense Industrial Associations (NDIAs) Strike, Land Attack and Air Defense (SLAAD) Committee was tasked by the Director, Theater Air Warfare (N865) in July 1996 to undertake an industry and Navy cooperative study on information management and tactical displays to support the AADC. The effort was endorsed by the Director of Navy Surface Warfare (N86). The final report is due for presentation and distribution during the spring of 1998. Thus it is timely to present the results of this study to MORS.

The general approach follows five steps: (1) define the AADC role, (2) identify what is currently available to do it with, (3) assess how well

the job can be done with what is available, (4) identify areas of improvement, and (5) provide a roadmap on how an improved AADC capability can be achieved circa 2010. Under that fabric, the AADC functions in the planning and execution phase were delineated; an information source matrix vs. each phase was generated; an information system architecture construct for an Aegis cruiser was proposed; and a display matrix for each AADC function to a display mode was mapped. Additionally, a methodology to identify the most promising emerging technologies was offered, with the top technologies illustrated by a quad chart showing a picture or schematic of the technology, current performance deficiencies, how these are reduced by the application of the technology, and the risk or maturity of that technology. For example, the key technologies in the tactical display area are color plasma display panels and active matrix liquid crystal displays. The report concludes with a list of AADC shortfalls and recommendations.

CVX Requirements Generation

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The Next Generation Aircraft Carrier (CVX) Program was faced with supporting the generation of an Operational Requirements Document (ORD) on an accelerated schedule of approximately one year. In order to comply with DoD guidance to use Cost as an Independent Variable (CAIV) and the desires of the program sponsor to involve the user community in the setting of operational requirements, a ORD generation plan was developed to meet this schedule. The major points of this plan included the description of the CVX in terms of quantifiable attributes, interaction with fleet users to determine their ranking of these attributes, an analysis plan to evaluate the contribution of these attributes to overall CVX effectiveness, a modeling and simulation plan to generate the effectiveness values, and a concurrent costing effort to enable the cost-effectiveness trades to be made. This paper will describe this process and its progress to date. Additionally, we will discuss the difficulties of developing a plan that required significant interaction with other major aircraft programs, as a major contribution to the effectiveness analysis is resident in the capabilities of the airwing embarked on CVX. We will also discuss the peculiarities of operations in the littoral battlespace and forecasting of threats for a platform that will enter the fleet in 2013 and have a life span for the class of ships that will reach to approximately 2090.

Thursday, 0830-1000 (Working Group Session # 6)

Joint Session WG 13 & 14 .... Room G-109

Surface Combatants for the Twenty-First Century

Dr. Matthew J. Vanderhill
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Last year the US Navy completed the most comprehensive and expensive COEA ever conducted. This two year Cost and Operational Effectiveness Analysis (COEA) on the Surface Combatants of the Twenty-First Century (SC-21) was constructed to answer the question of what surface ships to build after the current production of the Arleigh Burke Destroyers (DDG-51) is completed. This paper will provide a top-level review of the activities of this study and summarize and compare the Decision Alternatives (or family of ships) and specific Ship Options considered. The first Decision Alternative, or DA, assumed the continued construction of Arleigh Burke Destroyers and was used as a baseline in the study. The second DA included a smaller Sea Dominance ship, a Large Capacity Missile Ship, and later a cruiser replacement. The third DA consisted of aggressive modernization for he DDG-51 ships, as new technology became available. The fourth DA contained a Maritime Fire Support Ship, and later a cruiser replacement. The COEA selection was the MFSS or land attack destroyer; this new ship will be called the DD-21. The later cruiser replacements will probably be called the CG-21 class.

Several Mission Effectiveness Analysis teams were created to evaluate the Ship Options, including Land Attack, Sea Battlespace and Air Battlespace Dominance, C4ISR, and Survivability. A brief summary of the findings of these teams will be provided along with an overall comparison of the Decision Alternatives.

SC-21 COEA, Part II: Campaign Analysis Results

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This presentation will summarize the findings of the campaign analysis conducted as part of the Surface Combatant 21 Cost and Operational Effectiveness Analysis (SC-21 COEA). Specifically, the findings will report on the following tasks that were assigned to the Campaign Analysis Team:

Development of SC-21 Operational Concepts, Assessment of the cost and effectiveness of four different SC-21 decision alternatives, Derivation of key system parameters, and Determination of SC-21 contributions to the land campaign. The presentation will also address the scenarios developed to support the analysis, the methodologies and analytical tools used to achieve the aforementioned tasks, the campaign-level measures of effectiveness selected to determine the contributions of the SC-21 alternatives, and the subsequent analytical results and recommendation as to what SC-21 alternative will best meet the needs of the Navy and Joint forces in the 21st century.

Thursday, 1030-1200 (Working Group Session # 7)

WG-14: Maneuver Warfare and Campaign Analysis

Modeling Maneuver Warfare: Incorporating Human Factors and Decision-making in Combat Modeling

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Most current models of combat are based on an attrition warfare paradigm, where destruction of enemy forces and material are the objectives. However, models based on attrition warfare approaches do not reflect the actual combat processes that lead to victory. The current US Marine Corps doctrine of Maneuver Warfare recognizes that the path to victory lies in more than destruction of material – for example, Marine Corps doctrine Publication – 1, "Warfighting," says, "the results of maneuver are both physical and moral. The object of maneuver is to shatter the enemy's cohesion, organization, command, and psychological balance." Clearly, any model that does not incorporate "cohesion, organization, command, and psychological balance" cannot reflect the relative strengths and weaknesses of Maneuver Warfare.

A serious handicap has been the lack of a conceptual model of Maneuver Warfare on a level that could be incorporated into computer simulations.

This presentation outlines a conceptual model of Maneuver Warfare. The scope of the model runs from non-combat "deterrence" operations through combat in major wars. It incorporates defining and modeling the sources of victory, incorporates human factors such as moral, cohesion, and fighting spirit, and creates a conceptual model of the degradation of command processes when under stress. The objective is to provide a common taxonomy, define interrelationships, and serve as a springboard towards a more detailed algorithmic-level development of a model of Maneuver Warfare.

Warfighting Analysis in a Ruck Sack (WARS)

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The US Army Concepts Analysis Agency has developed a warfighting analytical support team, which has demonstrated the capability to provide a deployable, responsive, real time warfighting campaign analysis to the theater level commander in the field. This significant accomplishment is the result of combining several advancements in operations research techniques, decision analysis methods, and state-of-the-art hardware and software development packages. Utilized by US Central Command (CENTCOM) and US Army CENTCOM (ARCENT), WARS has been employed to conduct course of action assessments, determine force allocation and requirements, develop war plans and serve as an exercise 'driver.' During Desert Storm, such analysis was conducted using a mainframe and typically required five days to complete a course of action assessment. WARS enables the same task to be accomplished in 2 – 3 hours to include production of decision maker quality products. Lieutenant General (Retired) Steve Arnold, former Commander of ARCENT, describes WARS as "...truly revolutionary, significant and influential..." and "...this capability could and should soon be proliferated to corps and divisions." Clearly, WARS is an analytical quantum leap forward in leveraging today's technology and portends how technology can assist the theater level warfighting commander's campaign decision making.

Thursday, 1330-1500 (Working Group Session # 8)
WG-14: Advanced Aviation Systems and Mission Effectiveness Analysis

Joint Strike Fighter (JSF) Study

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Concepts and Technologies for the Future of JSEAD

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In the face of increasing sophisticated enemy integrated air defense systems (IADS), the Joint Suppression of Enemy Air Defenses (JSEAD) planner and warfighter will be required to have smarter and faster weapons, faster reaction times, innovative concepts as well as improved methods of collaborative mission planning. The Joint Suppression of Enemy Air Defenses Mission Area Architecture (JSEAD MAA) study, chartered by DEPSECDEF, explored new ways and means of conducting JSEAD in the 2006 timeframe and beyond. Modeling and Simulation (M&S) was used to evaluate and provide insights to the mission planning and effectiveness of current and future battlefield concepts, systems and technologies against a sophisticated threat.

A three-step approach was used in modeling the JSEAD systems, CONOPS and enemy IADS. First, a basic enemy IADS was developed by subject-matter-experts. This threat was representative of current enemy IADS without employing advanced emission control or mobility. Service representatives then developed the CONOPS, using current technologies, to suppress the IADS and provide strike force protection. Using the same JSEAD CONOPS, a second vignette enhanced the enemy IADS to represent a sophisticated threat envisioned in the future. This provided insights to shortfalls in the current JSEAD battlefield concepts, systems and technologies against future IADS. The third vignette explored innovative JSEAD techniques and technologies to suppress the sophisticated IADS. These techniques and technologies included innovative use of jamming with strike missions, faster and smarter standoff weapons, non-traditional C4ISR, and the use of unmanned platforms as suppressors, escorts and decoys. The focus of this presentation will be future JSEAD execution, M&S methodologies, advanced technologies and the innovative concepts analyzed in this OSD-J-8 study.

WG 15 - AIR COMBAT ANALYSIS & COMBAT ID - Agenda

Chair: Mrs. Audree D. Newman, AF/XOC-AFSAA
Cochair: Mr. Doug Kupersmith, S3I
Cochair: Mr. Scott Semmelmayer, McDonnell Douglas
Cochair: LT Rob Renfro, NAIC/TAAE
Advnisor: Dave E. Spencer, RAND
Room: G-130

Tuesday, 1030 - 1200
The Value of Air Target Positional Accuaracy in a Combat ID Network
Charles Sadowski Jr., et al, Veridian, Veda Group

Combat ID Modeling in Brawler
Karen E. Childers, System Simulation Solutions, Inc

Sensitivity Analysis of Brawler Pilot Skill Levels
Daniel Buschor, Maj, USAF and Ray Hill, Maj, USAF, Air Force Institute of Technology

Tuesday, 1330 - 1500
Silicon "Snake Oil" or Missile Engagement Simulations for the DOD
Dr. Rex Rivolo and Dr. Gary C. Comfort, Institute for Defense Analyses

Importance of Aircraft Survivability
Lawrence B. Wilkins and Carl Gerber, ANSER, Inc.

Wednesday, 830 - 1000
Fundamentals of Wargaming
Ramon Cortes, Lt Col, USAF, Air Force Studies and Analysis Agency

Pre-Analysis of the Global Engagement 97 Scenario
David B. Lee, System Solution Solutions, Inc (S3I)

Air Force Participation in Title X Wargaming, FY 1997
Tim McIlhenny, Maj, USAF, Air Force Studies and Analysis Agency

Wednesday, 1030 - 1200
Joint Strike Fighter (JSF) Study
Dr. L. Dean Simmons, Institute for Defense Analyses

ROK-US Air Power vs North Korean Long-Range Artillery
Mark A. Abramson, Capt, USAF, HQ ROK-US Combined Forces Command (CFC)

Wednesday, 1330 - 1500
Carrier Air Wing Capabilities Assessment
Kim McEligot, CDR, NAVY, et al, CINCPACFLT (N64/N33)

Effectiveness of Aircraft Alternatives for the Combat Search and Rescue (CSAR) Missioin
George E Thompson, ANSER Inc.

Upgrading AWACS Mission System Performance - Is It Worth It?
Charles Sadowski Jr., et al, Veridian, Veda Group

Thursday, 830 - 1000
1000/2000 lb. Strike Weapons Study
Ken Amster, Naval Air Warfare Center, China Lake

Airborne Laser Salvo Engagement Capability Study
Garry L. Hall, Maj, USAF, Air Force Studies and Analysis Agency

Optimizing Assignment of Air-to-Ground Assets and BDA Sensors
Kirk A. Yost, Lt Col, USAF, Operations Research Department, Naval Post Graduate School

Thursday, 1030 - 1200
C4I Analysis Across a DIS Network
Dave Smith, Capt, USAF, et al, DET 4, 505 CCEG (TACCSF)

Foreign Integrated Air Defense Systems - Generically Assessing Performance
David Panson, National Air Intelligence Center (NAIC/GTI)

A Methodology for Establishing, Assessing, and Quantifying Family of Systems Interoperability Requirements for Alternative Theater Air Missile Defense BMC4I SR Architectures
Dennis Mensh, Sr., et al, PRC, Inc.

Thursday, 1330 - 1500
Modeling Random Movement of Military Platforms
Dr. Philippe Loustaunau, Systems Planning and Analysis, Inc.

Grenadier BRAT WRAP Requirements Analysis
Patrick G. Smock and John M. Harwig, Maj, Army, TRADOC Analysis Center

SACTS - A Low-Cost, Rangeless ACMI System for Fighter Squadrons
Dr. Urban H.D. Lynch, UHL Research Associates, Inc.

WG 15 - AIR COMBAT ANALYSIS & COMBAT ID – Abstracts
Room: G-130

Tuesday, 1030-1100
The Value of Air Target Positional Accuracy in a Combat ID Network

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It is well known that target location information sent to a typical air-to-air fighter from an off-board source (like AWACS) has been and probably always will be positionally inaccurate, whether it is relayed by data link or voice. These errors are attributable to INS errors, errors in determining true north, processing delays, errors made by the tracking program on the off-board platform, human error, and transmission delays, just to name a few. If the errors are large enough, they can have a disastrous effect on identifying friendly and hostile air targets, leading to deadly confusion. A loss in mission effectiveness can result (Example: hostile bomber getting through to a target) or a self-inflicted fratricide can result if a critical ID mistake occurs from a correlation error due to excessive positional errors. When are the positional errors so large that unacceptable consequences are happening at alarmingly high rates?

This briefing uses data collected from a constructive simulation and analysis effort conducted by the Air Force Research Laboratory called the Correlation Accuracy Requirements Study (CARS). The paper addresses the issues involved with using off-board ID information and correlating the information to onboard radar information. The goal is to be able to maximize the use of off-board information while minimizing the tragedies caused by incorrectly correlating target information due to significant off-board positional error.

Tuesday, 1100-1130
Combat ID Modeling in Brawler

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In the Brawler Air Engagement Model, much effort has been put into modeling fighter aircraft, their avionics and weaponry, and the tactical use of these systems. Combat ID, within the scope of the air engagement, is modeled to some degree, but has not been used as rigorously as other parts of the model. Most Brawler studies have assumed that combat ID is not a factor, and allow both Red and Blue aircraft to fire at targets without specifically assessing ID. Brawler does provide three levels of ID Rules of Engagement (ROE) (1) No ID required, (2) electronic ID required, and (3) visual ID required. "No ID" and "visual ID" are relatively straightforward. However, there is a wide range of possibilities in between, and using electronic ID to cover all of these adds many assumptions into the scenario. In addition, the modeling of ID capabilities (IFF and NCID) is of lower fidelity and allows less flexibility than that of other avionics.

In current studies at ACC Studies and Analyses Squadron, we are focusing on the effects of combat ID capabilities and ROE in the air engagement. The effort includes modifications to Brawler to increase the fidelity and flexibility of the ID devices modeled in Brawler. In addition, we will look at the definitions of the ROE allowed, and how to make these more flexible using Brawler's Production Rules. An analysis of how the Brawler pilot's "mental model" establishes, retains, and drops ID's, and how it differentiates aircraft in close proximity, as well as how it uses the ID information will be accomplished. The final analysis will be an assessment of how various ID capabilities and ROE affect the engagements being studied.

Tuesday, 1100-1130
Sensitivity Analysis of Brawler Pilot Skill Levels

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BRAWLER is a high resolution air-to-air combat simulation model used for engagement-level analyses of few-on-few air combat. It uses a value driven decision logic to help simulate pilot behavior. In order to account for varied pilot skill levels, BRAWLER has defined three skill levels; Rookie, Pilot, and Ace. A Rookie can track up to three aircraft in its mental model, the Pilot, up to five aircraft, while an Ace has no limit. Further, each skill level varies the amount of time before a known aircraft, which has not been recently observed, is purged from the pilot's mental model (i.e., memory time). Past analyses using BRAWLER have exclusively used Ace pilots. This thesis focuses on the effects due to pilot skill level in air-to-air combat by using different combinations of Rookie, Pilot, and Ace skill levels in the BRAWLER air-to-air engagement model.

Tuesday, 1330-1415
Silicon "Snake Oil" or Missile Engagement Simulations for the DOD

Dr. Rex Rivolo, Research Staff Member, and
Dr. Gary C. Comfort, Assistant Division Director
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A fundamental building block of virtually all air combat analyses is the P_k (probability of kill) of an aircraft when engaged by a surface-to-air or air-to-air missile. Due to safety constraints, such P_ks are very difficult to obtain from the firing of real missiles versus realistically maneuvering aircraft. Consequently, the analysis community - and the decision makers that rely upon such analyses - have been forced to obtain P_ks from missile engagement simulations. For the major portion of the missile's flyout, the so-called Launch Acceptability Region, the target is unresolved (point source) and the missile flyout is characterized by "middle-of-the-envelope" aerodynamics and linear flight dynamics without saturation effects. Simulations are well suited to characterize this portion of the flyout. However, the real determination of miss distance (the primary determinant of P_k) occurs over the last one or two kilometers of the flyout. This region is characterized by edge-of-the-envelope missile aerodynamics, nonlinear flight dynamics and, oftentimes, saturation effects. Under these conditions, the 2-dimensional distribution of miss distances is not centered at the target, but typically shows a significant bias. The flyout models in common use fail to account for such bias, since they do not accurately represent the terminal trajectory problem, and resort instead to using a zero-bias, stochastic dispersion for miss distance determination. The consequence is that the resulting P_ks are "hard-wired" a priori into the simulation and thus undermine the credibility of all higher-level mission and theater analyses. This paper details and illustrates the reasons why current models can not produce credible miss distances and outlines an approach to replace the flawed stochastic methods with a physics-based simulation.

Tuesday, 1415-1500
Importance of Aircraft Survivability

Lawrence B. Wilkins, Senior Operations Research Analysis
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This study assesses aircraft survivability in a campaign environment to determine if loss rates incurred by aircraft mixes in the Generic Campaign Scenario are excessive. Historical data are used to define bounds for acceptable and non-acceptable loss rates. The THUNDER model is exercised on a baseline case of two different aircraft mixes in the Generic Composite Scenario to calculate expected loss rates, given assumptions on the aircraft mix, capabilities and countermeasure effectiveness, as well as the threat composition and capability. Loss rates for this baseline case are developed. Then, two alternate cases are simulated for variations in the countermeasure effectiveness of the two aircraft mixes; resulting loss rates are also developed. A third alternate case is considered for a specific variation in the threat environment, and loss rates are developed for both this specific variation independently as well as in conjunction with the other two alternate countermeasure effectiveness cases. The resulting loss rates from the various modeled cases show a statistically significant effect of aircraft mix survivability on expected loss rate under the conditions of the scenario.

Wednesday, 0830-0900
Fundamentals of Wargaming

Lt Col Ramon Cortes, Chief Wargaming Branch
Maj Tim McIlhenny, Analyst Wargaming Branch
Air Force Studies and Analysis Agency
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Fundamentals of Wargaming is a wargaming primer that discusses the basics of military wargaming. This primer is an educational tool. The primer provides a clear definition of what a wargame is and what it is not and it explains wargaming strengths and weaknesses. This primer examines the uses of wargaming in DOD and the Air Force. Finally, the primer discusses the dangers and misuses of wargaming.

Wednesday, 0900-0930
Pre-Analysis of the Global Engagement 97 Scenario

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Global Engagement '97 was an exercise sponsored by the Chief of Staff, United States Air Force. The game emphasized basing and employing forces, force structure adequacy, and appropriate courses of action for a simulated major theater conflict. System Simulation Solutions, Inc (S3I), in concert with Air Force Studies and Analyses Agency and the Air Force Wargaming Institute, conducted a pre-analysis of the Global Engagement '97 scenario to provide observations and insights to support the Global Engagement assessment teams. Analysis consisted of establishing a baseline case and several excursions using the THUNDER campaign model. The baseline case described the forces and capabilities of forces in the conflict and probable course of action for both sides. Metrics examined included ground movement, attrition, air losses, and munition expenditures. Excursions assessed the impact of political and logistics constraints.

Wednesday, 0930-1000
Air Force Participation in Title X Wargaming, FY 1997

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With a renewed emphasis in wargaming the Air Force expanded its participation in all aspects of Title X wargaming. Each service has its own Title X wargaming series; the Army, with Army After Next (AAN); the Navy, with its venerable Global series; and the Air Force, with Global Engagement (GE) series. This presentation discusses how air and space power were portrayed in the AAN winter and summer wargames, Global 97, the GE Pregame and GE 97.

Wednesday, 1030-1115
Joint Strike Fighter (JSF) Study

Dr. L. Dean Simmons
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Because many of the tactical aircraft types currently operated by the U.S. armed forces will reach the end of their planned service lives early in the next century, the Department of Defense recently established the Joint Strike Fighter (JSF) Program. The objective of the JSF Program is to develop a common family of aircraft that could meet the projected future needs of the Air Force, Navy, and Marine Corps. Given a total DoD buy of nearly 3,000 aircraft, the procurement costs for the JSF Program will exceed $100 billion, even if cost goals are met. Because the projected costs for the planned JSF buy are so large, Congress has expressed particular interest in the program. In particular, the National Defense Authorization Act for Fiscal Year 1997 requests that IDA conduct an assessment of the capabilities and costs of future U.S. tactical air forces, taking into account the potential effects of alternative JSF configurations. The objectives of the study are to (1) identify alternative tactical aircraft force structures that include different numbers and configurations of the Joint Strike Fighter aircraft, (2) assess the capability of those forces to meet the anticipated range of threats projected by the intelligence committee for the period 2000 - 2025, and (3) estimate the life-cycle costs associated with the JSF and its derivatives as well as the effects of those costs on overall tactical aircraft force costs.

Wednesday, 1115-1200
ROK-US Air Power vs North Korean Long-Range Artillery

Mark A. Abramson, Capt, USAF, Senior Air Analyst
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Headquarters, Combined Forces Command, Operations Analysis Branch, conducted a study to assess the effectiveness of the current air plan, in which a new air employment strategy is introduced, against the North Korean long-range artillery threat. Classical single-engagement binomial attrition equations, as used by the Tactical Warfare (TACWAR) joint combat simulation model, are applied with modifications to fit the new strategy and mathematically relax the common assumption that targets are always vulnerable to attack. The modifications were implemented into a Microsoft Excel attrition model, which includes as input data, enemy threat data, planned sortie allocations, and single-shot probabilities of detection and kill. Results for the current plan are presented, along with sensitivity analysis examining the effects of degrading or increasing numbers of sorties. Attrition rates and sortie efficiency are computed for each case. Optimization approaches for maximizing attrition are also suggested. Findings and conclusions drove major changes in the development of the next Integrated Tasking Order, aircraft deployment mixes, and employment tactics.

Wednesday, 1330-1400
Carrier Air Wing Capabilities Assessment

CDR Kim McEligot, Fleet Strike Warfare Officer
Dr. Robert Hubbard, Systems Analyst
Mr. Adam Davidson, Operations Research Analyst
CDR Charles Frye, Modeling and Simulations Officer
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In preparation for the FY00 budget cycle, CINCPACFLT conducted a study to determine the most cost effective number and configuration of strike fighter aircraft within the Carrier Air Wing given expected deck loading and fiscal constraints.

This brief describes specifics of operational effectiveness modeling for multi-mission strike aircraft. Conducted under a compressed time-line, the study used Thor and CASES/ASBAT Monte Carlo simulations of strike fighter and support aircraft against realistic air defense threats. Attempts were made to capture the multi-mission capability of the FA-18E/F and FA-18C as well as improvements in near-term air-to-ground ordnance. The study examined sortie generation capability and weapons effectiveness, the key factors in both offensive and defensive scenarios.

Wednesday, 1400-1430
Effectiveness of Aircraft Alternatives for the Combat Search and Rescue (CSAR) Mission

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This study compares the effectiveness of the H-60 helicopter and the V-22 tiltrotor for the Combat Search and Rescue (CSAR) mission. The authors represent future CSAR requirements by applying projected loss rates to actual coalition sorties flown in Operation DESERT STORM. Mission effectiveness (number and percentage of rescues versus downed rescue crewmembers) is computed using a computer model developed by ANSER. The model, a deterministic expected-value simulation, represents probability of rescue as a negative exponential function of elapsed time, and uses a multi-channel, multi-server queuing discipline to allocate limited rescue aircraft capability to demand. Compared to the H-60, the V-22 achieves approximately 3 times the number of saves per downed rescue crewmember. (Study excursions on operations concepts and deployment timelines show this ratio increasing to between roughly 4 and 7 times the H-60 effectiveness.) These results are sensitive to the relative survivability of the H-60 and V-22; further study in this area is warranted. The study also concludes that the V-22 is far more resource-efficient than the H-60, with estimated savings in support resources equivalent to dozens of aerial refueling tankers, several hundred tons of support equipment, thousands of support personnel, and dozens of strategic airlifters.

Wednesday, 1430-1500
Upgrading AWACS Mission System Performance - Is It Worth It?

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Current AWACS mission system inefficiencies associated with the INS navigation system, IFF jitter, the current target tracker, and processing/transmission delays associated with the main computer/JTIDS are well known and documented. Positional errors can be large, the delays in getting the information to a network (like Link 16) can be long, and AWACS operator frustration with the current target tracker is well documented. But what if we made improvements to the AWACS mission system that reduced these problems? Surely, the accuracy of target location and ID would be improved and delays in transmitting a clean air picture would be reduced. But would there be an impact on battlefield performance when the AWACS/F-15 team is conducting a Defensive Counter-Air (DCA) mission? Would more Red aircraft be killed? Would more Blue aircraft survive?

This briefing uses data from the 1997 the human-in-the-loop Sensor to Shooter Study conducted at the Theater Air Command and Control

Simulation Facility, Kirtland AFB, NM. A two week war was waged where improvements to the AWACS mission system were tested against the baseline mission system in a simulated air battle involving over 80 aircraft on every mission. How good were the improvements? Did the improvements make dramatic improvements in the offensive capability (killing Red aircraft) or the defensive capability (Blue aircraft survival) in a demanding air-to-air war? Did the improvements affect workload or reduce human factor mistakes? Attend the briefing to find out!

Thursday, 0830-0900
1000/2000 lb. Strike Weapons Study

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This study evaluated the relative operational effectiveness of selected Joint Strike Fighter (JSF) weapons and weapons loads against key mission specific targets. Emphasis was placed on the Navy's participation in a joint forces operation during the first few days of a major conflict. This study evaluated different internal carriage configurations, defined in terms of the potential free fall and glide weapons loads that could be carried, and calculated how many sorties were required to kill a given target set. The analysis included developing a realistic target set based upon Defense Planning Guidance and other Command guidance, and employing appropriate delivery profiles within a Joint Munitions Effectiveness Manual (JMEM) framework to calculate single sortie kill probabilities. These values were used to estimate the expected number of sorties required to accomplish Navy strike tasking. Further, the effects of employing different tactical doctrine was also evaluated. This study was conducted for the Chief of Naval Operations, Air Warfare Division.

Thursday, 0900-0930
Airborne Laser Salvo Engagement Capability Study

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The Airborne Laser (ABL) is designed to engage and destroy Theater Ballistic Missiles (TBMs) before they can complete the boost phase of their trajectories. The ABL's ability to "kill" a given TBM depends on a variety of environmental, system design, and spatial factors – some of which are time dependent. In the case of a TBM salvo (a group of TBMs that have launch times relatively close to each other), battle management can also be a significant factor. This study looked a various technical and operational factors using two basic approaches to characterize ABL's capability against TBM salvos and identify the major factors that effect that capability. In the first approach, the ABL was centered on a grid which defined a set of TBM launch points. ABL effectiveness was then determined for salvos launched under a range of conditions from these grid locations. In this case, the ABL was frozen in place while engaging the TBMs. In the second approach, ABL's effectiveness was evaluated using "operational" scenarios. In this case, the ABL is free to move and react while engaging the TBMs. The study also looked at defining the degree to which results from the first approach could be applied to predicting ABL operational effectiveness.

Thursday, 0930-1000
Optimizing Assignment of Air-to-Ground Assets and BDA Sensors

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It has been difficult to analyze the tradeoffs between sensors that do bomb-damage assessment (BDA) and attack assets. The general feeling is that better BDA leads to fewer sorties and weapons expenditures, but this has been difficult to quantify. We present an analytical optimization model that directly assigns aircraft, weapons, and BDA sensors to targets. This model assesses the campaign contribution of all these resources, and can be used to analyze the tradeoffs between advanced weapons and improved sensors. We will show computation results with representative campaign data.

Thursday, 1030-1100
C4I Analysis Across a DIS Network

Capt Dave Smith, Michael Gray, Senior Analyst, George T. Cherolis, Senior Analyst
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Many programs have successfully integrated Joint distributed simulations and real systems using DIS protocols to provide effective

simulation of the Joint Warfare environment. Few programs have been able to fully analyze the events that occurred during these exercises or experiments. The Tactical Air Command and Control Simulation Facility (TACCSF) has established a simulation and data collection methodology, architecture, and analytical tool set capable of computing a robust set of C4I MOE/MOP for tests conducted on a DIS network linking virtual, and constructive simulations in a Joint virtual battle space. No new DIS PDUs or additional bandwidth during test execution is required. Each distributed site captures the required data from its simulations or systems during realtime and then does a simple reformat and transmits the data across the T1 to other sites. The data files from distributed sites are then merged in a MS Access relational database to generate a combined Trial Event History for analysis. Examples of key queries used for coordinate and time transformations will be shown. In addition a flow chart of the complex queries which merge truth location and identity information from DIS Entity State PDUs with the appropriate recorded TADIL messages (perceived information) will be discussed.

This presentation will cover the current state of TACCSF's ability to provide accurate and timely data collection on critical operational events to facilitate analysis of performance and effectiveness of Joint operational concepts or C4I systems being tested across a DIS network. Operational performance measures will be addressed from the perspective of an air and missile defense analyst.

Thursday, 1100-1130

Foreign Integrated Air Defense Systems - Generically Assessing Performance

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Approved abstract not available at printing.

Thursday, 1130-1200

A Methodology for Establishing, Assessing, and Quantifying Family of Systems Interoperability Requirements for Alternative Theater Air Missile Defense BMC4I SR Architectures

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This paper develops basic concepts for the evaluations of Force, Battle Management Command, Control, Communications, Computers, Intelligence, and Surveillance and Reconnaissance (BMC4I SR), Interoperability of Family of Systems (FoS) architecture alternatives. The FoS interoperability requirements are determined from a Joint Forces perspective. The methodology employs Models and Simulations such as the Extended Air Defense Testbed (EADTB), Extended Air Defense Simulation (EADSIM), etc.

The methodology consists of a set of logical steps that are iterative by design. It provides insights and valid estimates of numerical measures of defines force requirements at several levels. *This process is not trivial; the expected level of effort could be significant.* The method consists of five basic stages necessary to achieve valid results. These stages are (1) determination of force level requirements, (2) determination of force level capability, (3) analysis of force level capability, (4) determination of FoS BMC4I SR requirements by battle overviews, and (5) determination of force level BMC4I SR requirements - overall.

This methodology can be used by Program Managers for determining top level BMC4I SR requirements for individual FoS in the battle force. In addition, once FoS levels of performance have been defined, the methodology generates a quantitative data base that becomes a useful tool for FoS suite selection. Once alternative combat system suites have been defined, these suites can be analyzed in terms of FoS performance capability versus cost.

Thursday, 1330-1400

Modeling Random Movement of Military Platforms

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We use the notion of a random walk with a drift, modeled to take place in a simulated, but realistic, geographic environment to model the movement of certain military platforms. This model is incorporated in the *Mapping Toolbox*, a broad set of tools for analyizing and displaying geographically based information. *Mapping Toolbox* works within MATLAB, a high performance technical computing environment that allows exploration, analysis, and design to solve the most complex and challenging problems. The *Mapping Toolbox* allows for the display of three dimensional geographic data and allows for the computation of vital geographic information accurately, such as true geographic distance and surface area, navigational parameters, missile paths, etc.

The movement model uses random walks along a path of intended motion using expected arrival times at certain expected key geographic locations to define a drift. It also incorporates movement constraints such as geographic areas forbidden to the platform, or areas unlikely to be traversed by the platform. The model outputs geographic probability density functions of the location of the platform, as it moves over time.

The movement model and the *Mapping Toolbox* can be used to analyze detection and search issues and examine red and blue strategies for detection and evasive countermeasures. It can also be used to analyze the combined impact of a number of platforms, such as combined targeting and coverage, or the relative geographic positions of these platforms. In addition, simulations and quick evaluations of operational parameters, such as operating areas, scheduling, alert status, etc. can be carried out. Some of these applications will be discussed during the presentation.

Thursday, 1400-1430
Grenadier BRAT WRAP Requirements Analysis

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Grenadier Beyond-line-of sight Reporting and Targeting (BRAT) device is a small, lightweight, manportable transceiver that receives location information from Global Positioning System satellite broadcasts and transmits unit identification, location, and other desired brevity coded messages to higher headquarters' command and control systems. Signals are relayed from Grenadier BRAT devices through existing satellite, aircraft, unattended aerial vehicle, aerostat, or tower systems.

The Grenadier BRAT Warfighting Rapid Acquisition Program Requirements Analysis was commissioned by the Battle Command Battle Laboratory – Fort Leavenworth in May 1997. The objectives of the analysis included:

- Determine Grenadier BRAT system-level capabilities and limitations, including capabilities of existing communications relay systems to process additional transmissions for Grenadier BRAT-equipped units.
- Evaluate the potential value of Grenadier BRAT's contribution to Army deep force situational awareness, with emphasis on corps-sized forces in multiple warfighting scenarios.
- Based on the previous evaluation, develop preferred quantities of systems for distribution within the Army force structure.

To meet the objectives of this study, TRAC and BCBL conducted a MAPEX to examine two approved operational scenarios based on TRADOC's Division Design Analysis.

Candidate distribution plans were developed for each scenario and evaluated in the MAPEX in order to develop a recommended preferred distribution of systems. This paper documents the results of the study effort.

Thursday, 1430-1500
SACTS - A Low-Cost, Rangeless ACMI System for Fighter Squadrons

Dr. Urban H.D. Lynch
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The Squadron Air Combat Training System(SACTS) is a low-cost, rangeless ACMI system that was successfully tested at the USAF Test Pilot School(TPS) Mch-May 1996. The purpose of SACTS is to provide a rangeless ACMI capability at each fighter squadron at a very low affordable cost. SACTS employs the Global Positioning System(GPS) to measure the position of each aircraft in the combat using commercial GPS receivers operating at 1- Hertz. The SACTS GPS commercial hardware is non-intrusive to the aircraft and is the primary reason why SACTS is low cost. Unique to SACTS is its Post Flight Processing(PFP) software that smoothes/filters the position data from the commercial GPS receivers to obtain timed aircraft position and angular-attitude data that is used to drive a 3D-graphic presentation of the air combat scenario on a laptop personal computer. The 3D-graphic software is known as the Air Combat Visualization & Analysis Tool(ACVAT). The presentation will describe the SACTS, its affordable technology, TPS test results, development status and include a SACTS computer demonstration of TPS air combat scenarios.

WG 16 - SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR - AGENDA

Chair: Mr. Robert C. Holcomb, IDA
Cochairs: Mr. Robert L. Smith, Raytheon
LTC Darrall Henderson, USSOCOM
Greg Jannarone, Consultant
COL Brian Maher, USAF Special Operations School
LTC Joel Parker, USSOCOM
Mr. Larry Redmond, GTE
Mr. Kevin Brandt, Mitre
Advisor: Mr. Ray Stratton, Lockheed Martin
Room: G-118

Tuesday, 1030-1200
Assessment of Analytic Tool Requirements for OOTW
Dr. Dean Hartley III, Oak Ridge National Laboratory

Improving Analysis and Planning for Complex Contingency Operations
Dr. Jacqueline Henningsen, OSD/PA&E, and Ms. Lynda Jaques, USCINCPAC/J53

Tuesday, 1330-1500
A Short History of Stability and Support Operations
Eugene P. Visco

Logistics Planning Factors and Capabilities for Army, Navy and Air Force Special Operations Forces
LTJG Timothy Lanquist, LT Brett S. Wagner, and CDR Michael F. Giancatarino, Naval Postgraduate School

Wednesday, 0830-1000
Joint Session with WG 19 .... Room I-122
SOF Mission Planning, Analysis, Rehearsal, and Execution Capabilities for the Future
CPT(P) Allan E. Bilyeu, Naval Postgraduate School

Modeling Logistics in Full Spectrum Operations/Military Operations Other Than War (FSO/OOTW) for Conventional and Special Operations Forces (SOF)
LT Jeff D. Goodmanson, Naval Postgraduate School

Wednesday, 1030-1200
Analysis in Support of USSOCOM and the Command's Strategic Planning Process
LTC Joel Parker, USSOCOM

High Resolution Recreations of Historical Special Operations Case Studies
Professor Bard Mansanger, Naval Postgraduate School

Wednesday, 1330-1500
Joint Session with WG 11 .... Room G-102

SOF-MEM: A Frontal Assault on the "Critical Meteorological and Oceanographic Thresholds for SOF Operations"
Mr. Anthony Cowden, Sonalysts, Inc.

An Intelligent Analysis Methodology for Military Reconnaissance and Surveillance Missions
Mr. Phillip L. Doiron, Applied Research Associates, Inc.

METOC Support to Military Operations Research: Special Operations Forces
Mr. David Pitcher, Naval Oceanographic Office

Thursday, 0830-1000
Information Gain and Loss
Donald R. Barr and CPT Jon Shupenus, United States Military Academy
Bosnia Air Operations: Lessons Learned
Dr. Dean Simmons, Institute for Defense Analyses

<u>Thursday, 1030-1200</u>
Bringing the USMC POM Process Into the 21st Century
MAJ Peter F. Long, Headquarters, United States Marine Corps

FALCON: A Machine Translation Support Tool for Nonlinguists
Ms. Ann E. M. Brodeen, US Army Research Laboratory

<u>Thursday, 1330-1500</u>
Stochastic Analysis for Deployments and Excursions (SADE)
LTC Patrick J. DuBois, US Army Concepts Analysis Agency

Army Model and Simulation Office OOTW Website
CPT Christopher J. O'Connor, Army Models and Simulation Office

WG 16 - SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR –ABSTRACTS
Room: G-118

<u>Tuesday, 1030-1200</u>
Assessment of Analytic Tool Requirements for OOTW

Dr. Dean Hartley III
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Center for Modeling, Simulation and Gaming
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This presentation reports the results of the Office of the Secretary of Defense/Program Analysis & Evaluation (OSD/PA&E) sponsored project to identify how Operations Other Than War (OOTW) tool requirements relate to the Joint Warfare Simulation (JWARS) and, more generally, to joint analytical modeling and simulation (M&S) requirements. An earlier, US Pacific Command (USPACOM) sponsored, project identified unmet requirements for OOTW analysis tools. Further insight into the tools was gained through a Military Operations Research Society (MORS) workshop. This presentation describes the study recommendations about which OOTW tools (and functionality within tools) should be included in JWARS, which should be managed as joint analytical modeling and simulation (M&S) tools, and which should be left for independent development. Some of the recommendations are already being implemented.

Improving Analysis and Planning for Complex Contingency Operations

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Ms. Lynda Jaques
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Efforts have been ongoing since February 1996 to improve the Department of Defense's ability to analyze and plan for small-scale contingency (SSC) operations. Complex contingency operations (CCOs) are a subset of SSCs that consist of those situations that occur within the auspices of PDD 56 where interagency participation typically is required. These operations are particularly difficult for DOD to plan for given the military normally is not in charge, and the mission is not warfighting. The tools and models that have supported DOD in the planning process in the past do not fit these situations. This presentation will (1) describe an ongoing effort designed to explore SSC-related planning and programmatic issues and to serve as a test-bed to examine the usefulness of several existing logistics and transportation tools, and (2) discuss a proposed next step to forward the development of analytic methodologies to satisfy the varying DOD requirements to analyze complex contingency operations.

<u>Tuesday, 1330-1500</u>
A Short History of Stability and Support Operations

Eugene P. Visco
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The paper expands on the author's observation that the United States has **declared** war less than 10 times in its 220 plus years history; it has **gone to** war about 100 times in the same period; but it has conducted stability and support operations about 1,000 times. [If anyone is counting, that is an exponential relationship.] The paper consists of a review of the history of US military stability and support operations commencing with the 1804-06 exploration mission of Captain Meriwether Lewis and Lieutenant William Clark, First U.S. Infantry. It covers exploration and pioneering in the early 19th century; more exploration, surveying and mapping, civil and labor disturbances, construction and road building, Indian management, disaster relief, and peacekeeping operations in the late 19th century; more disaster relief, civil and labor

disturbances, interventions (Central and South America and the Caribbean), and more peacekeeping in the first half of the 20th century. The paper dispels the myth that post-Cold War operations undertaken by the US military, whether unilateral or combined (under the UN or regional institutions), are new and somehow unique. How many people recall that, in addition to fighting and commanding in the War of 1812, the Mexican War, and the beginning of the Civil War while serving over 50 years on active duty, General Winfield Scott also conducted three major peacekeeping missions for the United States?

Logistics Planning Factors and Capabilities for Army, Navy and Air Force Special Operations Forces

LTJG Timothy Lanquist, LT Brett S. Wagner, and CDR Michael F. Giancatarino, USN
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United States Special Operations Forces (SOF) are the most highly trained and well-equipped forces in the world. Although this statement is without question true, there are certain capabilities they are lacking in. The most visible and most overlooked is logistics. Under Title 10 each service must provide logistic support to its Special Operations Force regardless of operating environment.

Currently, there are no SOF unique planning factors available that can help logistics planners in their assessment of SOF logistics requirements. Current estimates are made using Army Light Infantry unit planning factors. Although these are sufficient in over-estimating most classes of supply, they do not take into account SOF unique items. Since there is no data currently available on actual SOF consumption rates, assumptions had to be made and conclusions had to be verified by the Commander in Chief, United States Special Operations Command's operational and logistics planners.

Logistics support for SOF units is primarily tasked organized. In order to develop the most efficient way to support single-service and joint SOF units, a baseline logistics support structure had to be developed for each service. Once developed., the baseline forces could be modified and integrated to support any combination of forces during a given mission profile.

Efforts are underway to integrate the three services logistics planning factors and support unit structures into a logistics planning tool for use by joint and component SOF logistics planners. The primary purpose of the planning tool will be to help logistics planners reduce the logistics footprint in theater while maintaining adequate logistics support to all units. Integration of this planning tool into future combat models may help to justify the need for a Joint Special Operations Logistics Command or other joint logistics infrastructure.

Wednesday, 0830-1000

Joint Session with WG 19 .... Room I-122

SOF Mission Planning, Analysis, Rehearsal, and Execution Capabilities for the Future

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The purpose of this thesis is to investigate the possibility of developing a platform independent mission planning, analysis, rehearsal and execution system for the United States Special Operations Command (USSOCOM). This thesis looks at the current need to move to platform independent technologies. This problem is particularly meaningful for the special operations community that could never expect to move to a standardized computer planning system for their joint, multi-national, and inter-agency operations. This thesis also investigates the ability to integrate legacy systems with new loosely coupled components in an open architecture on an object web. In addition, this thesis incorporates current operations research methods into this system to show their importance. The planning and analysis system is developed in the JAVA programming language. The system only involves an image component that contains a map with overlays. An object web established with a common operating request broker attempts to integrate legacy systems with this image component. To show the relevance of this system a scenario involving joint and coalition forces is developed. The scenario demonstrates the usefulness and need for platform independent planning and analysis systems. Finally, this thesis recommends a possible architecture structure that USSOCOM should investigate for the future of its mission planning, analysis, rehearsal, and execution systems.

Modeling Logistics in Full Spectrum Operations/Military Operations Other Than War (FSO/OOTW) for Conventional and Special Operations Forces (SOF)

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Because the nature of FSO/MOOTW which most often involve Special Operations Forces (SOF) are significantly different than traditional combat missions, the simulation and analysis of these topics lag far behind combat modeling. In the area of logistics, this is particularly true since even traditional combat models lack sufficient logistics planning and analysis tools. The purpose of this study is to support the efforts of USPACOM in development of logistics and mobility planning tools for FSO/MOOTW in particular and SOF in general. A large body of work has been completed on planning and analysis tools for U.S. military forces. However, the nature of FSO/MOOTW has

driven a requirement for tools that would include non-U.S./Allied military, inter-agency, and non-military personnel as well as their logistics assets and non-traditional material.

The first step to accomplish this is to define an FSO.MOOTW logistically. The variety of missions that are defined under this term mean there are a wide variety of participants and some missions may overlap. This often depends on the perspective of the particular CINC. The next step is to conduct a survey of existing models in all services that perform logistics functions. From this survey, it can be determined where some methods or fuctionality may be useful to modeling a FSO/MOOTW scenario. The data necessary to develop a model and the sources, U.S. and non-U.S., must also be determined. The study will not present a model, but rather a design architecture for follow-up efforts in modeling FSO/MOOTW.

Wednesday, 1030-1200

Analysis in Support of USSOCOM and the Command's Strategic Planning Process

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United States Special Operations Command's (USSOCOM) mission is to prepare Special Operations Forces (SOF) to successfully conduct worldwide special operations, civil affairs and psychological operations in peace and war in support of the geographical Commanders in Chief (CINCs) , the American Ambassadors and their respective country teams, as well as other United States government agencies. To execute this mission, USSOCOM is Congressionally funded through the Major Force Program 11 (MFP-11) to: (1) Develop doctrine, tactics, techniques and procedures for SOF; (2) Conduct specialized courses of instruction for all SOF; (3) Train assigned forces and ensure interoperability of equipment and forces; (4) Monitor the preparedness of SOF assigned to other unified commands; (5) Develop and acquire SOF unique capabilities; (6) Consolidate and submit program and budget proposals for MFP-11 funding; and, (7) Monitor the promotion, assignments, retention, training, and professional development of all SOF personnel. USSOCOM's Wargaming, Simulation and Analysis Division --which works for the Director, Force Structure, Requirements, Resources and Strategic Assessments Center (SORR)-- is charged with providing analytical support to the Command's mission. A fundamental prerequisite to successfully prosecuting the Command's mission, is adequate congressional funding. To obtain the necessary funding, USSOCOM must formally participate in the Department of Defense Planning Programming and Budget system (PPBS). The Command's Strategic Planning Process (SPP) is designed to meet critical prerequisite. The purpose of the SPP is to provide a prioritized list of capabilities-base programs, over a range of constraints, that allows senior decision-makers to satisfy SOF mission needs and proactively guide the development of SOF resources into the future.

The challenge for the Wargaming, Simulation and Analysis Division (SORR-SC) is to provide the entire SOF community (USSOCOM and its assigned SOF components) with robust, quality analytical support while providing comparable analytical support to the SPP in preparation of the Command's Program Objective Memorandum (POM) submission to the Joint Staff, the Department of Defense and Congress. To accomplish this support, the Division is moving towards a concept of collaborative analysis. Collaborative analysis includes: Current, Program, Future and Exploratory analyses. Current analysis is geared to supporting current analytical needs, while Program analysis focuses on supporting the SPP and POM. Future analysis provides support to the United States Commander in Chief Special Operations Command (USCINCSOC) vision of SOF in the out years while Exploratory analysis is designed to supplement Current analysis. This presentation will provide an overview of SORR-SC analytical support concept as well as highlight some key analyses underway within the Division.

High Resolution Recreations of Historical Special Operations Case Studies

Professor Bard Mansanger
Department of Mathematics
US Naval Postgraduate School
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Using the Janus (Version 6.0) high resolution combat simulation, several "classic" Special Operations have been recreated and further examined to determine other possible outcomes given slight variation of the known input parameters. This presentation features selected Naval Postgraduate School (MPS) students' examination of Special Operations case studies enumerated in William H. McRaven's book, Spec Ops. McRaven analyses eight "classic" Special Operations conducted by the United States, British, German, Israeli, and Italian forces executed from the sea, air, and land. As a course requirement, NPS Applied Mathematics and Operations Research students enrolled in a bigh resolution modeling class were required to reconstruct a historical battle to include creating a terrain file that captures the actual battlefield and database adjustments to properly portray the weapons and forces used in that engagement. From that base case, excursions were conducted to answer the "what if's" that always seem to surface after the battle. Several Measures of Effectiveness (MOEs) were selected to compare various excursions and to attempt to quantify results. The presentation will include a Janus replay of selected operations and the subsequent analysis. The purpose of this research is not intended to demonstrate statistical rigor, but rather the use of a high resolution model in providing a tool to recreate interesting engagements and provide the investigator with a means for analysis.

Wednesday, 1330-1500

Joint Session with WG 11 .... Room G-102

SOF-MEM: A Frontal Assault on the "Critical Meteorological and Oceanographic Thresholds for SOF Operations"

Mr. Anthony Cowden
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At the 65th MORSS we gave a presentation detailing the development and architecture of a decision support system (DSS) for relating environmental factors to mission effectiveness (*The Special Operations Forces (SOF) Mission Effectiveness Model (MEM): A Fuzzy Logic Decision Support System*). In this presentation we will discuss the use of threshold values for tactical decision making contained in the "Critical Meteorological and Oceanographic Thresholds for SOF Operations," and show how the use of discrete parameters in decision making, in both human and computer based decision making, can be extremely dangerous and lead to poor decisions. We will also discuss how experienced tactical decision makers correctly use these parameters as guidance, and how a fuzzy decision support system, such as the Special Operations Forces (SOF) Mission Effectiveness Model (MEM) incorporates these same parameters.

An Intelligent Analysis Methodology for Military Reconnaissance and Surveillance Missions

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Approved abstract unavailable at printing.

METOC Support to Military Operations Research: Special Operations Forces

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Knowledge of the impact of Meteorology and Oceanography (METOC) conditions on both friendly and opposing forces is vital to the planning, rehearsal, and execution of military operations. Environmental factors can serve as cover, or as an impediment to operations. METOC conditions affect mobility, weapon/sensor performance, communications, life support, and risk to personnel and equipment. Exploiting tactical knowledge of environmental conditions acts as a force multiplier, increasing the probability of success. To provide warfighters a decisive tactical advantage, a thorough understanding of the spatial and temporal variability of METOC parameters is required. These environmental parameters include atmospheric conditions, ocean dynamics, water column properties, seafloor properties, biological hazards, hydrological conditions, and coastal characteristics. This information is essential for conducting military operations research.

Special Operations Forces (SOF) mission planning and execution involve a continuous series of choices in response to a dynamic set of environmental and tactical conditions. To help mission planners and decision-makers appreciate the impact of the METOC environment on platforms and personnel, a document entitled Critical Meteorological and Oceanographic Thresholds for SOF METOC Operations is published by the United States Special Operations Command. A review of this document is provided.

Support to SOF dictates the requirement for accurate environmental data in the littoral zone on current and expected (modeled) conditions. SOF operations exert stringent requirements, both spatially and temporally, on environmental models and data collection systems. Models and collection methods that were successfully used to support "blue water" requirements cannot easily be transitioned to the littoral environment. The problem is one of both scale and environmental complexity. An evaluation of present capabilities to measure and predict the METOC parameters required to support SOF mission planning, rehearsal, and execution is provided. Expected near-term and far-term advances in modeling and remote sensing technology areas that show promise for addressing these deficiencies are presented.

To support military operations research systems effectively, the discovery and dissemination of METOC information must be standardized to facilitate rapid access and accurate fusion with other digital information. Issues associated with this concept, such as metadata fields, data models, data interchange mechanisms, and the development of METOC Geographic Information Systems, are discussed.

Thursday, 0830-1000
Information Gain and Loss

Donald R. Barr and CPT Jon Shupenus
United States Military Academy
West Point, NY 10996
914-938-4374

We present a simple model for measuring the amount of information gained through scouting and intelligence. We discuss effects of sensor capabilities and prior information such as terrain features on the behavior of information gain. Based on assumed stochastic properties of a mobile target whose location cannot be continuously monitored, we demonstrate how information about the target decays over time. We conclude that consumers of satellite and UAV data and other sources of intelligence might tend to over-estimate the amount of information retained when contact with a mobile target is broken.

Bosnia Air Operations: Lessons Learned

Dr. Dean Simmons
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This study identifies lessons learned from the extensive air operations conducted by the United States and NATO in support of United Nations peace keeping activities in the former Yugoslavia between April 1992 and November 1995 when the Dayton Peace Agreement was initialed. As the first significant operation ever undertaken by NATO and one of the largest and most complex military operations-other-than-war conducted in recent years by U.S. forces, the air operations over Bosnia provide substantial information of value throughout the U.S. military. This study reviews those operations in detail, identifies the principal lessons learned, and assesses the implications of those lessons for future system acquisitions, force planning, and force employment concepts. All aspects of the operations are covered in the assessment, including operational objectives, coalition considerations, command arrangements, rules of engagement, command and control, intelligence, and the various air operations themselves. The results of the study should be of broad benefit throughout the Department of Defense.

Thursday, 1030-1200
Bringing the USMC POM Process Into the 21st Century

MAJ Peter F. Long
Decision Support Branch, Programs and Resources Dept, HQMC
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Washington, DC 20380-1775
703-697-9582

The USMC continues to refine its Program Objective Memorandum (POM) process. In an effort to increase the rigor and replicability in the process, and to streamline the prioritization of competing programs, Headquarters, USMC, Programs and Resources Department, the POM Process 'owner' has recently explored and instituted procedures to this end. The basic challenge facing the USMC (and all services) is that our REQUIREMENTS outweigh our RESOURCES, or, in layman's terms, we can't afford the Marine Corps the nation needs. So the challenge becomes to have the best Marine Corps our limited budget can afford. Implementation of COTS technology and the desire to implement changes to our current system will enhance our ability to WIN BATTLES and MAKE MARINES. This presentation will provide a historical perspective of the USMC POM process, discuss the alternatives explored by our department, and illustrate how implementing these changes assist the Marine Corps in getting the most bang for our buck.

FALCON: A Machine Translation Support Tool for Nonlinguists

Ms. Ann E. M. Brodeen
US Army Research Laboratory
ATTN-AMSRL-IS-CI
Aberdeen Proving Ground, MD 21005-5067

The Forward Area Language Converter, or FALCON, is a small, lightweight document reader and translator now in prototype. The system couples a laptop computer and sheet-fed scanner with optical character recognition and text-to-text translation software. FALCON is intended to assist nonlinguists in the forward area of the battlefield assess the significance of captured foreign documents. Military personnel placed in front positions of a foreign mission often encounter printed documents in a language they cannot understand. With this portable document analysis tool, the nonlinguist can scan a printed page, recognize individual characters with the scanned image, and produce a rough English translation to evaluate with automated keyword searches. This procedure gives nonlinguists in the field a way to identify captured documents that match a profile of keywords defined by analysts specifically for the situation. Documents that pass this relevance filter can then be sent back, along with the rough translation produced, for further processing by linguists and analysts. FALCON has been developed through the joint efforts of the Army Research Laboratory (ARL), the Air Force National Air Intelligence Center, the Defense Advanced Research Projects Agency, and the intelligence community. This paper provides an overview of the FALCON technology, feedback from users in Bosnia, and a discussion of the use of FALCON as a testbed for MT concepts as part of ARL's research and development program in human language technology, including emerging methodologies for the evaluation of MT systems and their components.

Thursday, 1330-1500
Stochastic Analysis for Deployments and Excursions (SADE)

LTC Patrick J. DuBois
US Army Concepts Analysis Agency
Bethesda, MD 20814
301-295-6931

The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of the events to which the United States (US) commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily commits to Major Theater Wars (MTW) and Small Scale Contingencies (SSC). These types of operations occur increasingly

more often and with much more uncertainty concerning event inter-arrival, duration, and the number/type of troops/equipment required. Due to recurring demands to justify force structure, the focus change and the increase in uncertainty inherent with these new types of operations, there is a need to forecast the number and type of operations the US Military will have to respond to simultaneously.

This paper discusses a methodology that is based on queuing theory and incorporates stochastic processes (simulation) using the simulation software AWESIM® to forecast the number of SSCs (by type) that the US Military could be involved in during the period 1998 to 2006. Although the methodology has many benefits, possibly the biggest may be its ability to estimate the distribution of the occurrence of simultaneous SSC operations. These estimates can be use to evaluate the risk associated with unit availability based on a given resourced force structure, as well as the development of requirements in the force structure development process. The methodology is described and results shown.

Army Model and Simulation Office OOTW Website

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Army Models and Simulation Office
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703-601-0012 x29

Since the Gulf War, the Army has had scores of separate deployments; many, if not all which could be categorized as Operations Other Than War (OOTW). OOTW requires a variety of tools for mission planning and training rehearsal. It is of vital importance that the model and simulation community is fully cognizant of the wide range of activities that occur in OOTW. To assist in meeting this need, the Army Model and Simulation Office (AMSO) has created a website. The purpose of the website is to share information regarding M&S products and to ensure that OOTW is considered when developing new M&S standards. The presenter of this paper is integral in the development of this website, which will aid in carrying the Army M&S community into Force XXI and the Army After Next.

WG 17 - JOINT CAMPAIGN ANALYSIS – Agenda

Chair: Mr. William C. Burch, Applied Military Technologies
CoChairs: COL Robert D. Clemence, Jr., OJCS J-8
CDR "Boots" Barnes, OSD(PA&E)
Cindy Noble, TRAC-FLVN
Jeff Paulus, General Research Corporation
Advisor: Richard P. Morris, The Boeing Company
Room: G-115

Tuesday, 1030-1200
Planning Future Military Forces
Daniel J. Shedlowski, US Army Concepts Analysis Agency

Operations Analysis in a Changing Europe--The European Command Experience
COL James R. Methered, Headquarters, US European Command

Tuesday, 1200-1245
Modeling C4ISR at the Joint Campaign Level Warfight
MAJ Ken Blanks, Defense Information System Agency

Tuesday, 1245-1300
Impact of SLOC Closure on MTV Execution
Michael A. Ottenberg, OSD PA&E Simulation and Analysis Center

Tuesday, 1330-1500
When Systems are Simulations--T&E, VV&A or Both?
Priscilla A. Glasow, The MITRE Corporation

The Necessity for Integrating Space Assets into Campaign Analysis
Capt James R. Hunter and Capt Mark A. Powers, Space Missile Center

Wednesday, 0830-1000
ROK-US Air Power vs. North Korean Long-Range Artillery
Capt Mark A. Abramson, HQ ROK-US Combined Forces Command

Quadrennial Defense Review Alternative Assessment
COL Forrest Crain, US Army Concepts Analysis Agency

Warfighting Analysis in a Ruck Sack (WARS)
COL Forrest Crain, US Army Concepts Analysis Agency

Wednesday, 1030-1200
COMPOSITE GROUP C SESSION.. Room G-109

Joint Warfare
Coordinator: Denis T. Clements

Wednesday, 1330-1500
JWARS: The Requirements Process
LtCol Jim Stevens, Joint Chiefs of Staff, J8

RMA, New measures of Effectiveness and Good Old Fundamental Objectives
LTC Dan Maxwell, OSD PA&E, JWARS Office

JWARS--Attrition
Major Paul J. Warhola, OSD PA&E, JWARS Office
JWARS Panel Discussion--Requirements, MOEs, Attrition, and Developments

Moderator: CDR "Boots" Barnes, JWARS Office.

Thursday, 0830-1000
Unequal Warfare: When Weak Powers Make War Against the Strong
Alan R. Goldman, National Ground Intelligence Center

Southwest Asia Low Resolution Scenario (SWALRS) 7.0
MAJ Charles E. Davis, TRADOC Analysis Center

Thursday, 1030-1115
Southwest Asia, Early Entry Deployability Analysis
CPT(P) Philip Buford, TRADOC Analysis Center

Thursday, 1115-1200
Examination of Methods to Input Leadership or Other "Soft Factors" into Models and Simulations
Gerald A. Halbert and Steven P. Ketterer, National Ground Intelligence Center

Thursday, 1200-1245
TACWAR-ITEM-JICM Comparison Study
Jeffrey A. Paulus, OSD PA&E, Simulation & Analysis Center

Thursday, 1245-1330
The DAWMS Process
James N. Bexfield, Institute for Defense Analysis

Thursday, 1330-1415
Importance of Aircraft Survivability
Lawrence B. Wilkins and Carl Gerber, ANSER, Inc.

WG 17 - JOINT CAMPAIGN ANALYSIS – Abstracts
Room: G-115

Tuesday, 1030-1115
Planning Future Military Forces

Daniel J. Shedlowski
US Army Concepts Analysis Agency
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The challenge in planning for military forces is to: 1) consider a Joint view of the missions military forces are to perform--be strategy based, 2) use a Joint view of how to conduct military operations--be concept and doctrine based, 3) consider all areas, all missions and threats, all time frames--be comprehensive, and 4) allow for uncertainty--be robust. The Army's force planning process, which has undergone significant evolution during the post cold war period and particularly during the recent QDR process, can serve as the foundation to transition to a Joint Planning Process that can meet this challenge. This presentation provides an overview of the evolving Army force planning process and concludes with the observation that this process is inherently joint and can be readily adopted as a Joint Planning Process for use by all Services.

Tuesday, 1115-1200
Operations Analysis in a Changing Europe--The European Command Experience

COL James R. Methered
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GE-49-680-5353

Approved abstract unavailable at printing.

Tuesday, 1200-1245
Modeling C4ISR at the Joint Campaign Level Warfight

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Tuesday, 1245-1300
Impact of SLOC Closure on MTV Execution

Michael A. Ottenberg
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Threat countries may engage in simultaneous--but not coordinated--military operations that will affect US interests world wide. What risks do synergistic and co-located Small Scale Contingency (SSC) and Major Theater War (MTW) warfights place on US force structure, strategic mobility, and pre-positioning programs?

This briefing describes the results of a "Scoping study" undertaken by PA&E's Simulation and Analysis Center (SAC), a study that analyzed US force sufficiency and capability issues in an environment where selected sea lines of communications (SLOC) are closed. The study included an analysis of strategic lift, pre-positioning, and alternative force flow issues. Some particular focuses of this effort were the exploration of excursions suggested by the Services, the use of the study to gain insights into the TACWAR 5.0 release, exploration of alternative information sharing formats, and use of the study to "scope" areas for further analysis.

The analysis was conducted for the Theater Assessment and Planning (TA&P) Directorate.

Tuesday, 1330-1500
When Systems are Simulations--T&E, VV&A or Both?

Priscilla A. Glasow
The MITRE Corporation
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(703) 883-6931

Modeling and simulation has traditionally been used to support the test and evaluation (T&E) of new programs. An earlier paper authored by Allen, Burleson and Glasow identified four cases for depicting the relationship of simulation to T&E. That paper initiated a dialogue on the similarities and differences between the T&E process and the Verification, Validation and Accreditation (VV&A) process which is used to assess the credibility of models and simulations.

This paper will address a fifth case in which the system under test is itself a model, simulation, or suite of models and simulations. In this case, the overlap of T&E activities with VV&A activities increases significantly. New theory is proposed to define the extent of that overlap and address the implications of Case 5 for conducting T&E and VV&A on a given model.

As an evolving hypothesis, the application of Case 5 to an actual program is only now beginning. The initial experiences gained from such applications as Joint Warfare System (JWARS) will provide insightful lessons as to how these closely related and often overlapping processes can be implemented in future programs. Additionally, valuable recommendations are expected to result which will aid the system sponsor in ensuring required system performance without unnecessary duplication of quality testing.

The Necessity for Integrating Space Assets into Campaign Analysis

Capt James R. Hunter and Capt Mark A. Powers
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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, and analysis (MS&A) community must take a hard look at the design and implementation on the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by RAND which only looks at a slice of the campaign given certain assumptions will be explored.

Wednesday, 0830-1000
ROK-US Air Power vs. North Korean Long-Range Artillery

Capt Mark A. Abramson
HQ ROK-US Combined Forces Command
Commander, CFC, CFCD-PL-OA
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001-82-2-7913-7673

Headquarters, Combined Forces Command, Operations Analysis Branch, conducted a study to assess the effectiveness of the current air plan, in which a new air employment strategy is introduced, against the North Korean long-range artillery threat. Classical single-engagement binomial attrition equations, as used by the Tactical Warfare (TACWAR) joint combat simulation model, are applied with modifications to fit the new strategy and mathematically relax the common assumption that targets are always vulnerable to attack, The modifications were implemented into a Microsoft Excel attrition model, which includes as input data, enemy threat data, planned sortie allocations, and single-shot probabilities of direction and kill. Result for the current plan are presented, along with sensitivity analysis examining the effects of degrading or increasing numbers of sorties. Attrition rates and sortie efficiency are computed for each case. Optimization approaches for maximizing attrition are also suggested. Findings and conclusions drove major changes in the development of the next Integrated Tasking Order, aircraft deployment mixes and employment tactics.

Quadrennial Defense Review Alternative Assessment

COL Forrest Crain
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The purpose of the QDR-AFA was to examine the Office of the Secretary of Defense (PA&E) analytic framework for comparing alternative force structure options and introduce additional force structure alternatives which were based on the operational requirements of specific theaters of operation.

Specific objectives accomplished in this study were: 1) a comparison of the OSD Force Structure Alternatives and a doctrinal, situationally based force alternative in terms of operational effectiveness and cost using the Deep Attack Weapons Mix Study (DAWMS) as the base case; 2) development of a template (response surface mapping) which illuminates alternative joint force structures required to minimally accomplish each campaign phase, map known force assessment alternatives onto the template, and use the template as a predictive tool for rapid evaluation of Dual-Major Theater War (MTW) force structure alternatives during the QDR; 3) develop an historical template for estimated Small Scale Contingency (SSC) force requirements. Add SSC and expected dual MRC force requirements to gain insights to the total force requirement.

The results of this study identified an alternative force which not only achieved the dual MTW national military strategy, but cost less than those OSD alternatives under consideration. This force alternative provided the Department of the Army's and subsequently the Department of Defense's final position in the QDR.

Warfighting Analysis in a Ruck Sack (WARS)

The US Army Concepts Analysis Agency has developed a warfighting analytical support team which has demonstrated the capability to provide deployable, responsive, real time warfighting campaign analysis to the theater level commander in the field. This significant accomplishment is the result of combining several advancements in operations research techniques, decision analysis methods, state-of-the-art hardware and software development packages. Utilized by US Central Command (CENTCOM) and US Army CENTCOM (ARCENT), WARS has been employed to conduct course of action assessments, determine force allocation and requirements, develop war plans and serve as an exercise "driver." During Desert Storm, such analysis was conducted using a mainframe and typically required 5 days to complete a course of action assessment. WARS enables the same task to be accomplished in 2-3 hours to include production of decision maker quality products. Lieutenant General (Retired) Steve Arnold, former Commander of ARCENT, describes WARS as "...truly revolutionary, significant and influential..." and"...this capability could and should soon be proliferated to corps and divisions." Clearly, WARS is an analytical quantum leap forward in leveraging today's technology and portends how technology can assist the theater level warfighting commander's campaign decision making.

Wednesday, 1030-1200
COMPOSITE GROUP C SESSION.. Room G-109

Joint Warfare
Denis T. Clements, OSD PA&E, JWARS Office

Wednesday, 1300-1330
JWARS: The Requirements Process

LtCol Jim Stevens
Joint Chiefs of Staff, J8
Pentagon, Washington, D.C.

The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF), Commanders/Staff, Joint Staff, Office of the

Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Courses of Action and Force Sufficiency analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the JWARS requirements process and building of the JWARS ORD. This process was a culmination of a year long effort that follows the guidance outlined in the DoD 5000.1 and 5000.2 acquisition documents for a ACT III level programs and Automated Information Systems (AISs). On 1 December 1997, after six months of concentrated effort with the Services and CINCs, the JROC reviewed and validated the JWARS KPPs and retained approval authority for the ORD as a Draft pending futher refinement of the Warfare Representations. The Joint Analytic Model Improvement Program (JAMP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for all other aspects of the JWARS program. Reporting procedures and status of the requirements process will also be discussed.

Wednesday, 1330-1500

RMA, New measures of Effectiveness and Good Old Fundamental Objectives

LTC Dan Maxwell
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Joint Vision 2010 prescribes a doctrine that capitalizes on emerging military and information technologies. The systems and doctrine are proven. Simulations and experiments have provided the requisite evidence; the long-awaited revolution in military affairs (RMA) has arrived.

The military operations research community has been a key part of the RMA. We have been the purveyors of quantitative evidence of the increasing efficiency of America's military. Given the RMA, we now seek new measures of effectiveness (MOE) that will help us to better demonstrate potential contributions of the new systems and doctrine. The hypothesis is accepted; the RMA is a robust replacement to existing capabilities and doctrine.

This paper postulates the existence of an enduring set of fundamental objectives that military analysts can apply as a foundation for their analysis in the future. These objectives are reflective of the essential reasons that national leaders are interested in military effectiveness. A chain of reasoning is then offered that connects these fundamental objectives to the tasks that are performed by military forces. The reasoning also connects the objectives to the doctrine and systems that are being developed to accomplish those tasks. The talk concludes with some thoughts on how the military analysis community could apply this paradigm to better support defense leaders.

JWARS--Attrition

Major Paul J. Warhola
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Arlington, VA 22209
(703) 696-9490

One brushstroke in the art of war is the destruction of the enemy's personnel, equipment and installations. A significant challenge to the Joint Warfare System (JWARS) development process is to appropriately represent attrition across all systems and environments within the specified runtime constraints. Algorithms span one-on-one engagements, such as anti-ship missile versus aircraft carrier, to highly aggregated brigade versus brigade battles. The final simulation will incorporate existing methods, improvements to the existing and some original approaches. This presentation will discuss algorithms, other appropriate design materials identified to date and outstanding issues.

JWARS Panel Discussion--Requirements, MOEs, Attrition, and Developments
Moderator: CDR "Boots" Barnes, JWARS Office.

Thursday, 0830-1000

Unequal Warfare: When Weak Powers Make War Against the Strong

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The United States is the leading power in the world. While, it is understandable that a great power should feel relatively secure in a world of lesser powers, predominance must not become cause for complacency. Throughout history there are many cases of stronger powers being attacked by the military forces of weaker powers. Japan initiated war against Russia in 1904 and the United States in 1941, although Japan was by the traditional measures of power--economic, industrial and military--the weaker power. In 1950 the peasant armies of China went to war in Korea against the world's superpower, the United States. This paper will examine why and how weaker countries make war against the strong. It will examine what factors are likely to create conditions that impel a weaker power to take the great risk of initiating war against a more powerful adversary. It will also look at some military principles and objectives countries are likely to employ when they choose to commit to war. By examining asymmetric war, US and allied joint campaign planners will gain a better appreciation of the kind of war the United States is likely to confront in the foreseeable future.

Southwest Asia Low Resolution Scenario (SWALRS) 7.0

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The TRADOC Analysis Center (TRAC) bases the SWALRS 7.0 on the Defense Planning Guidance (DPG) and the SWA Theater Resolution

Scenario (TRS) 2.0 also developed by TRAC. SWALRS 7.0 assumes United States forces are involved in the second of two major theater war (MTW). The scenario is a joint defensive operation employing forces and doctrine based on Army of Excellence force structure and current day doctrine. The force year is 2006 for Blue and 2011 for Red forces.

One of the objectives of this effort is to provide a realistic and reusable tool that can be used to examine joint deep strike and maneuver warfare. The scenario incorporates deep strike, interdiction, close air support, SEAD, theater air defense as provided by naval and ground forces, amphibious operations, maneuver warfare, surveillance, reconnaissance, joint communications, support operations and coalition forces in order to analyze US capabilities in defeating threats. This scenario provides a tool for analyzing numerous capabilities in a joint context.

Thursday, 1030-1200
Southwest Asia, Early Entry Deployability Analysis

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This effort conducted by TRADOC's Study and Analysis Center (TRAC-SAC) in conjunction with the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA), assesses the force structure startex conditions for an early entry Southwest Asian scenario. As the second of two Major Regional Conflicts (MRC) defined by the Defense Planning Guidance FY 1998-2003 (DPG), this scenario's force structure is limited to projected 2006 prepositioned assets along with those assets which can be flown into theater given finite projected 2006, strategic lift assets. This assessment answers the question "what force can deploy given the timeline outlined in the DPG?"

The analysis uses two models in tandem: the Joint Flow and Analysis System for Transportation (JFAST) and the Enhanced Logistics Intratheater Support Tool (ELIST). JFAST models deployment to the Port of Debarkation (POD) while ELIST models the movement of forces from the POD onward to their Tactical Assembly Areas (TAAs). The first step in the analysis is to identify those forces needed for the scenario. The second step is to build the Time Phased Force Deployment List (TPFDL) ensuring the proper phasing of the forces. The third step is to tailor the force into Force Modules (FMs) to track the day to day movement of forces in ELIST. The final step is to assess when elements of the joint force get to their TAA given limited assets.

This effort focuses on Joint Forces. The Army force is one heavy division derived primarily from prepositioned ground and prepositioned afloat assets. The Marine Element includes a Marine Expedition Force (MEF) Forward whose assets originate on MEPSRON I. The Air Force element includes 3.5 FWE/30 Bombers along with the needed signal, maintenance, and engineer elements to operate ten air bases throughout the region; all assets self deploy or fly into theater. No naval combat assets are in the TPFDL due to their offshore role. The initial and sustainment supplies originate in prepositioned stocks and are phased in the TPFDL, although the commodities in the TPFDL can no be determined. All personnel with the exception of naval and Marine Pre-positioning Force (MPF) personnel fly into theater and are in the TPFDL.

Approved abstract for the following presentations unavailable at printing.

Examination of Methods to Input Leadership or Other "Soft Factors" into Models and Simulations

Gerald A. Halbert and Steven P. Ketterer
National Ground Intelligence Center
220 Seventh Street, NE
Charlottesville, VA 22902
(804) 980-7560

Thursday, 1200-1330
TACWAR-ITEM-JICM Comparison Study

Jeffrey A. Paulus
OSD PA&E, Simulation & Analysis Center
Oak Hills Building, Suite 300
1401 Wilson Boulevard
Arlington, VA 22209-2306
(703) 696-9360

The DAWMS Process

James N. Bexfield
Institute for Defense Analysis
1801 N. Beauregard Street
Alexandria, VA 22311-1772
(703) 845-2107

Importance of Aircraft Survivability

Lawrence B. Wilkins and Carl Gerber
ANSER, Inc.
1215 Jefferson Davis Highway
Arlington, VA 22202
(703) 416-3527

WG 18 - MOBILITY & TRANSPORT OF FORCES - Agenda

Chair: Mr. Franklin McKie, USACAA
Cochair: Mr. Thomas Denesia, AFMC OAS/DR
Cochair: Lt Col Jim Moore, AFIT/ENS
Cochair: Major Steve Baker, US Air Force Academy
Cochair: Mr. David Merrill, HQ AMC/XPY
Advisor: Dr. Yupo Chan, AFIT/ENS
Room: I-265

Tuesday, 1030 - 1200
COMPOSITE GROUP D SESSION... Room G-109

Tuesday, 1330 - 1500
Mobilization Capabilities Evaluation Model (MOBCEM) Update
Julianne Allison and Franklin McKie, US Army Concepts Analysis Agency

The Intertheater Mobility Analysis Component (IMAC) of JWARS
Carroll Keyfauver, GRC International

An Efficient Algorithm for Calculating Shortest Paths while Avoiding Obstacles
Emmet R. Beeker, GRC International

Wednesday, 0830 - 1000
Strategic Dominant Maneuver and High Speed Sealift
LTC Robert M. Toguchi and MAJ Joseph T. Gerard, Strategic Mobility Cell, Operations, Plans and Policy, Army Staff

Air Force THUNDER Airlift Study
Scott Emert, System Simulation Solutions, Inc. (S3I)

An Airlift Hub-and-Spoke Location-Routing Model With Time Windows: Case Study of the CONUS-to-Korea Airlift Problem
Major David W. Cox and Dr. Yupo Chan, Air Force Institute of Technology/ENS

Wednesday, 1030 - 1200
Southwest Asia, Early Entry Deployability Analysis
CPT(P) Philip Buford, TRADOC Analysis Center

Applications in Advanced Mobility Modeling
Dr. Elizabeth N. Abbe and Franklin McKie, US Army Concepts Analysis Agency

Joint Sizing Study for Time Definite Air Sustainment
David de Haan, Dynamics Research Corporation

Wednesday, 1330 - 1500
Rapid, Flexible Deployment Planning Technique Using the Strategic Lift Integrated Model
Jerry Butler, Coleman Research Corporation

Stochastic Analysis for Deployments and Excursions
LTC Patrick J. DuBois, US Army Concepts Analysis Agency

Modeling Using Dynamic Network Algorithms
Lawrence J. Fess, J. Curtis Badgett and Robert Taft, Joint Warfare Analysis Center

Thursday, 0830 - 1000
Quantifying the Benefits of Aircraft Modernization on Airlift Force Effectiveness
David A Arthur, Harold S. Balaban and Kevin M. Eveker, Institute for Defense Analyses

Thursday, 1030 - 1200
Sensitivity Analysis and Experimental Design Evaluation of Vehicle Mobility Performance Using the NATO Reference Mobility Model
John G. Green, U.S. Army Engineer Waterways Experiment Station

Low-G Extraction Personnel Platform for Precision Air Drop (LEP3ARD)
Lt Col Lance Acree, SAF/AQQM

Thursday, 1330 - 1500
Experiment in Modeling Focused Logistics (EMFL)
Dr. Kevin Saeger and Elaine Simmons, OSD/PA&E and CAPT Dave Cashbaugh, Joint Staff (J-4) Mobility Division

WG 18 - MOBILITY & TRANSPORT OF FORCES - Abstracts
Room: I-265

Tuesday, 1030 - 1200
COMPOSITE GROUP D SESSION.. Room G-109

Tuesday, 1330 - 1500
Mobilization Capabilities Evaluation Model (MOBCEM) Update

Julianne Allison, Frank McKie
US Army Concepts Analysis Agency
ATTN: CSCA-MD
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Bethesda, MD 20814
(301) 295-1588, (301) 295-1699

MOBCEM will be a critical tool for providing the Army the ability to evaluate and improve mobilization capability. The model will provide the capability to simulate mobilization operations and analyze theater capabilities and shortfalls in connection with major force structuring studies. It will also allow for mobilization analysis of capabilities and issues independent of the theater combat models. MOBCEM will model the mobilization system from Home Station (HS) to Port of Embarkation and will include the modeling of Active Component and Reserve Component units, individual personnel, and materiel at all levels of mobilization through full mobilization. When completed, it will allow CAA, the ARSTAF/MACOMs, and OSD to respond to requests for studies/analyses of various aspects of the mobilization process.

MOBCEM is currently in Phase II of three phases of development. Phase I focused on processing which takes place at HS and Mobilization Station (MS)/Power Projection Platform (PPP). All servicing areas, e.g., billeting, readiness evaluation, medical/dental processing, administrative processing, theater orientation, training, etc., are represented where appropriate at these stations. The other major nodes (CONUS Replacement Center, Training Center, and POE) are being designed and implemented in Phase II, which started in July 1997 and is expected to be completed in late 1998. The mobilization processes of the other services will be added in Phase III. MOBCEM will be a component of the Joint Warfighting System (JWARS). This presentation will cover the features, capabilities, status, and potential applications of MOBCEM.

The Intertheater Mobility Analysis Component (IMAC) of JWARS

Carroll Keyfauver
GRC International, 1900 Gallows Road
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JWARS Program Office, 1555 Wilson Blvd, Suite 619
Rosslyn, VA 22209
(703)-696-9490

The strategic mobility modeling component of Joint WARfare System (JWARS) must operate with the integrated JWARS software interacting with the JWARS combat model and also must operate as a separate model. In order to interact with the combat model, the mobility model must be event-driven with high resolution of transportation assets, facilities, and cargo as potential theater targets. At the same time the model must run fast, react to events in the evolving war game, and be an integral part of the modeling of logistics in JWARS.

When completed, the IMAC subsystem of JWARS now in development will satisfy all of these objectives with an object-oriented design. IMAC will provide the theater command and control system with current and projected delivery schedules of combat forces, support forces, and sustaining cargo. The model will react to theater inventory shortfalls, attacks on theater ports and lines of communication and changes in the JTF Commander's priorities and requirements. The model will recognize the arrival of cargo reception units and equipment to grow port throughput capacity.

This presentation will discuss design issues and proposed solutions for representing the transportation networks, transport vehicles, mode selection and port assignment, unit integrity and sustaining supply requirements.

An Efficient Algorithm for Calculating Shortest Paths while Avoiding Obstacles

Emmet R. Beeker, Senior Analyst
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We present an efficient algorithm to calculate route distances for transportation models. This algorithm uses Voronoi diagrams, and their dual, Delaunay triangulation, to build shortest paths on the Earth's surface while avoiding obstacles defined by closed sets of points (polygons). While Voronoi diagrams were introduced in 1850, it is only within the last fifteen years that efficient algorithms have been developed to produce and use them. The algorithm we show is efficient enough to be used within models to build shortest routes from arbitrary positions at sea to any (or all) ports, avoiding land and utilizing canals. It can also be used for air routing around restricted areas, no-fly zones, and hazardous weather. It is being implemented in the Intertheater Mobility Analysis Component (IMAC) of the Joint Warfare System (JWARS) to replace the SAIL network used by its predecessor, MIDAS.

Wednesday, 0830 - 1000
Strategic Dominant Maneuver and High Speed Sealift

LTC Robert M. Toguchi
MAJ Joseph T. Gerard
Strategic Mobility Cell, Operations, Plans and Policy, Army Staff
400 Army Pentagon, Washington, D.C. 20310-0400
(703) 695-4846

Future military operations will require the deployment of decisive combat power from the continental United States almost directly into the theater of operations to achieve the strategic goals of the National Military Strategy. Speed of deployment will be critical to preventing future adversaries from establishing conditions that either prevent or delay the deployment of forces, or compel the U.S. military to become engaged in a prolonged conflict. High Speed Sealift (HSS) vessels can provide strategic platforms that will reduce deployment times from weeks to days and enable us to rapidly shift forces and logistics within theater to achieve success.

Current strategic sealift vessels travel at a speed of approximately 24 knots. HSS vessels have the potential to travel at speeds of between 40 and 100 knots by the year 2010 and provide an order of magnitude increase in ship capabilities. Each vessel could carry up to a battalion task force equivalent of combat power, be refueled at sea, and be quickly discharged directly at an austere port or onto a beachhead. A fleet of such strategic sealift vessels could allow the U.S. military to rapidly project technologically advanced combat forces of the Army After Next anywhere in the globe within days, thus providing the military with the means to rapidly counter armed threats to critical areas by providing superior positional advantage.

This presentation will discuss the basic technological feasibility for such craft, as well as some specific hull designs that provide this breakthrough in sealift technology. Finally, this presentation will discuss how such vessels may serve the joint military community and possibly fit into the emerging military strategy of the 21st Century.

Air Force THUNDER Airlift Study

Scott Emert, Senior Programmer
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Approved abstract unavailable at printing.

An Airlift Hub-and-Spoke Location-Routing Model With Time Windows: Case Study of the CONUS-to-Korea Airlift Problem

David W. Cox, Major, USAF, Graduate Student at AFIT
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Traditionally, the United States Air Force's Air Mobility Command (AMC) has used the concept of direct delivery to airlift cargo and passengers from a point of embarkation to a point of debarkation. This study develops an alternative hub-and-spoke combined location-routing linear programming prototype model with this ultimate goal: to determine if hub-and-spoke permits shorter cargo closure times without sacrificing tonnage delivered, compared to direct delivery. Three types of bases are incorporated: supply bases (hubs for the C-5s), transshipment bases (hubs for the C-17s), and destination (demand) bases. The model features the following elements: time windows, cargo tracking capability, multiple frequency servicing, aircraft basing assignments and routing, and the selection of the optimal number of C-17s to be used. The model is an extension on the following works: the hierarchical model of Perl and Daskin (1983), time windows features of Chan and Baker (1991), combining subtourbreaking and range constraints (Kuikarni and Bhave, 1985) and multiple servicing frequency via the clustering co-location method for binary variables (Baker, 1991). Additionally, an original approach for cargo tracking is developed and incorporated. As a case study, the CONUS-to-Korea transoceanic airlift problem is used to test the model.

Wednesday, 1030 - 1200
Southwest Asia, Early Entry Deployability Analysis

CPT(P) Philip Buford
TRADOC Analysis Center
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255 Sedgewick Avenue
FL Leavenworth KS 66027-234S
(913) 684-9219

1. Purpose. This effort, conducted by TRADOC's Study and Analysis Center (TRAC-SAC) in conjunction with the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA), assesses the force structure startex conditions for an early entry Southwest Asian scenario. As the second of two Major Regional Conflicts (MRC) defined by the Defense Planning Guidance FY 1998-2003 (DPG), this scenario's force structure is limited to projected 2006 prepositioned assets along with those assets which can be flown into theater given finite projected 2006, strategic lift assets. This assessment answers the question "what force can deploy given the timeline outlined in the DPG?"

2. Methodology. The analysis uses two models in tandem: the Joint Flow and Analysis System for Transportation (JFAST) and the

Enhanced Logistics Intratheater Support Tool (ELIST). JFAST models deployment to the Port of Debarkation (POD) while ELIST models the movement of forces from the POD onward to their Tactical Assembly Areas (TAAs). The first step in the analysis is to identify those forces needed for the scenario. The second step is to build the Time Phased Force Deployment List (TPFDL) ensuring the proper phasing of the forces. The third step was to tailor the force into Force Modules (FMs) to track the day to day movement of forces in ELIST. The final step was to assess when elements of the joint force get to their TAA given limited assets.

3. Scope. Joint Forces. The Army force is one heavy division derived primarily from prepositioned ground and prepositioned afloat assets. The Marine Element includes a Marine Expedition Force (MF) Forward whose assets originate on MEPSRON I. The Air Force element includes 3.5 FWE/30 bombers along with the needed signal, maintenance, and engineer elements to operate ten air bases throughout the region; all assets self deploy or fly into theater. No naval combat assets are in the TPFDL due to their offshore role. The initial and sustainment supplies originate in preposition stocks and are phased in the TPFDL, although you can not determine the commodities identity within the TPFDL. All personnel with the exception of naval/Marine Pre-positioning Force (MPF) personnel fly into theater and are in the TPFDL.

Applications in Adivanced Mobility Modeling

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US Army Concepts Analysis Agency
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In order to address the complexity and widening scope of mobility issues and concerns, the US Army Concepts Analysis Agency (CAA) has developed a high resolution transportation modeling system for the comprehensive simulation of end-to-end force deployment. The Global Deployment Analysis System (GDAS) will deploy troops and equipment from CONUS/OCONUS origins to theater tactical assembly areas (TAAs) and any subsequent redeployment as desired. GDAS, which combines a multi-modal entity model with a relational database system, provides seamless simulation of mobility of forces from origin to within theater destination (i.e., initial tactical assembly areas). GDAS is unique in its capability to distribute distinct types of cargo onto vehicles of multiple modes (e.g., road, rail, air, sea, pipeline, inland waterway) across an expandable global network with detailed facility structure. GDAS combines scheduling techniques for effective selection of mode, route, and assignment of vehicles with an objective of achieving timely deployment in combination with efficient use of resources based on user priorities. The GDAS data structure is expandable by network, vehicle type, and facility type. Results from various applications based on simulations of both single and nearly simultaneous deployment of US forces into Major Theater Wars (MTW) for current and future time frames are presented. Focus will be on lift asset trade-offs, RSOI assessment, and the impacts of chemical and other attacks on port operations. These applications will illustrate the unique advanced features of GDAS.

Joint Sizing Study for Time Definite Air Sustainment

David de Haan
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Dynamics Research Corporation
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Arlington, Virginia 22202
703-412-2812 ext 6089

During Operations Desert Storm/Desert Shield (DS/DS), the United States Transportation Command (USTRANSCOM) and its air component, Military Airlift Command (now Air Mobility Command or AMC), developed an express air cargo system to handle the U.S. Central Command's warstopper requirements and patterned it after commercial carrier's express service. This system was commonly referred to as Desert Express (DE). Based on the successes of DE, AMC developed a concept to contract out the consolidation of the cargo shipments from AMC customers to a commercial cargo carrier's facility. This concept is now known as Air Mobility eXpress (AMX) and will provide joint wartime time-definite CONUS-to-theater delivery of high priority cargo. AMX would take advantage of commercially developed systems and facilities, eliminating a step performed during DE operations.

This study builds upon the results of a similar study conducted by Dynamics Research Corporation (DRC) in September 1996 to define the US Air Force Time Definite Air Sustainment requirements (presented at MORSS 97).

The purpose of this analysis is to determine comprehensive sizing data for the three remaining Military Services (USA, USN, USMC) and to consolidate this data with the sizing data from the previous USAF study in order to determine the total assets required to support wartime operations and to provide contractual strategies.

<u>Wednesday, 1330 - 1500</u>

Rapid, Flexible Deployment Planning Technique Using the Strategic Lift Integrated Model

Jerry Butler
Coleman Research Corporation
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(703) 527-0000

Military operations in the 21st Century will be characterized by very rapidly changing missions and situations, and high degree of uncertainty. DoD has experienced a drastic increase in commitment of manpower to military operations around the globe over the past 15 years. These types of operational commitments will be the dominant issues for the services in the future. These operations will require rapid and

flexible planning in the face of the many constraints. Deliberate planning has taken place for many major Regional Contingencies using large detailed models. If the adversaries of the future would adhere to the planned scenarios, execution of OPLANS would be very effective. However with many troops committed to other operations, in other countries, airlift committed to other contingencies and potential for neutral or non-neutral countries to restrict the flow of US forces due to political situations (overflight), use of airports/seaports or facilities, etc.

The Strategic Lift Integrated Model (SLIM) was designed to provide time phased flow of forces to theatre to support analysis for Theater Missile Defense (TMD) campaign studies. SLIM provided accurate depiction of missile defense forces, as part of the overall Joint Task Force, arriving in theater throughout the campaign allowing for a more realistic analysis of the campaign. SLIM provided the capability to show Air and Sealift of forces from CONUS, intratheater and intertheater simultaneously. SLIM was redesigned to provide a more comprehensive and detailed analysis of strategic lift allowing for rapid change of constraining parameters and a very user friendly GUI for ease of use by the new user.

SLIM provides a new look at tools for the operational planner and analyst. SLIM operates on a Personal Computer (PC) and could be used in the field or in the office by virtually anyone required to conduct a rapid operational analysis. With SLIM the planner can quickly assess the feasibility of a deployment plan and if it's not feasible determine why. SLIM can be used to assess the utility of TPFDDs and aid in the development of TPFDDs when time and transportation resources are limited. Planners can conduct "What-if" drills to examine how to change deployment plans if air or seaports suddenly become unavailable or lose some throughput capacity due to hostile action or equipment breakdowns. SLIM currently provides accurate intertheater analysis, and plans are underway to be enhanced to provide an end-to-end tool for analysis from "Fort to TAA".

This presentation will focus on the use of SLIM for rapid and flexible planning for mobility operations and utility of tools like SLIM for emergency deployments and other contingency operations.

Stochastic Analysis for Deployments and Excursions

Patrick J. DuBois, LTC, PhD
US Army Concepts Analysis Agency
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The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of the events to which the United States (US) commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily commits to Major Theater Wars (MTW) and Small Scale Contingencies (SSC). These types of operations occur increasingly more often and with much more uncertainty concerning event inter-arrival, duration, and the number/type of troops/equipment required. Due to recurring demands to justify force structure, the focus change and the increase in uncertainty inherent with these new types of operations, there is a need to forecast the number and type of operations the US Military will have to respond to simultaneously.

This paper discusses a methodology that is based on queuing theory and incorporates stochastic processes (simulation) using the simulation software AWESIM® to forecast the number of SSCs (by type) that the US Military could be involved in during the period 1998 to 2006. Although the methodology has many benefits, possibly the biggest may be its ability to estimate the distribution of the occurrence of simultaneous SSC operations. These estimates can be used to evaluate the risk associated with unit availability based on a given resourced force structure, as well as the development of requirements in the force structure development process. The methodology is described and results shown.

Modeling Using Dynamic Network Algorithms

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Many military problems involve moving people, materials or both within the shortest time (quickest transshipment) or within a specified time (dynamic transshipment). Recently, an algorithm has been published by Bruce Hoppe to solve these problems in strongly polynomial time using dynamic networks. We are currently implementing this algorithm as one basic model underlying our network analysis for military applications.

The advantages to using dynamic flow networks are: (a) For multiple time periods, the network representation does not have to be duplicated for each time period as with traditional time-expanded networks. This means significantly less memory is required for networks that are handling multiple time periods; (b) The run-time is proportional to log (T) rather than T. Because dynamic network flows are often used to model continuous time real-world problems, a polynomial solution time is desired as the granularity of the model increases; and (c) A better representation of the network is achieved since the traversal times of arcs are directly represented in the network and there is no need for intermediate nodes to be created.

Examples will be provided and computational results discussed.

<u>Thursday, 0830 - 1000</u>

Quantifying the Benefits of Aircraft Modernization on Airlift Force Effectiveness

David A Arthur, PhD. Research Staff, Harold S. Balaban, PhD. Adjunct., Kevin M. Eveker, PhD. Research Staff.
Institute for Defense Analyses
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In today's environment of restrictive defense budgets, service life extension and modernization programs for existing systems have attracted interest as alternatives to costly new procurement. This trend is well illustrated by the consideration Air Mobility Command is currently giving to modernizing its aging C-5 and C-130 fleets. In addition to simply extending service lift, the insertion of modern technologies into these existing airframes promises improvements in both aircraft reliability and performance. Assessing the operational benefits of such improvements in reliability and performance compared to new aircraft can be critical to determining the best approach for meeting future airlift

requirements. This paper describes the analytical methods used in these studies together with selected results. It will include approaches for measuring reliability and performance improvements and will demonstrate how the airlift system can impact the operational benefits achieved from these improvements.

Thursday, 1030 - 1200
Sensitivity Analysis and Experimental Design Evaluation of Vehicle Mobility Performance Using the NATO Reference Mobility Model

John G. Green
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
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Vehicle mobility performance is affected by numerous vehicle parameters such as vehicle payload, suspension, and horsepower. In designing and/or modifying vehicles, it is important to evaluate the impact of parameter design configurations on resultant mobility. The U. S. Army Engineer Waterways Experiment Station conducted a study during FY97 for the Naval Surface Warfare Center to identify pertinent vehicle design parameters which affect mobility performance of the Logistic Vehicle System Rebuild (LVSR) and to systematically determine the configuration of parameters yielding the optimum mobility performance for a range of payloads. Initially a sensitivity analysis was conducted as a screening procedure to identify vehicle parameters influencing mobility. The NATO Reference Mobility Model (NRMM) was used to generate vehicle speeds for comparison of various vehicle parameter settings over distinct areas of terrain in the Philippines, South Korea, and Kuwait. Manufacturing constraints and issues were considered in selecting candidate parameters for vehicle modification and design changes. After the set of candidate parameters, or factors, was selected, experimental design procedures were employed to identify significant factors and factor interactions and to evaluate combinations of factor settings resulting in significantly improved mobility. Performance measures used were the Mobility Rating Speed (MRS), percent NOGO, and the average vehicle speed over a terrain area. Methodology and results will be presented.

Low-G Extraction Personnel Platform for Precision Air Drop (LEP3ARD)

Lance Acree, Lt Col
SAF/AQQM
1570 Air Force Pentagon
Washington, DC 20330-1570

In the changing world environment, our ability to seize an objective by conventional means may no longer be a viable solution, especially in Operations Other Than War (OOTW). OOTWs provide a new set of threats and flying large aircraft slow and low to the ground may incur unacceptable casualties. The Low-G Extraction Personnel Platform for Precision Air Drop (LEP3ARD) may be the answer to these and many other problems that Strategic Brigade Airdrop faces. A joint analysis methodology will also be presented.

Thursday, 1330 - 1500
Experiment in Modeling Focused Logistics (EMFL)

Dr. Kevin Saeger
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CAPT. Dave Cashbaugh
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As a major initiative under JV 2010, focused logistics is intended to combine improvements in information, logistics, and transportation technologies to provide for the delivery of tailored sustainment packages to the theater. The Joint Staff (J-4) and OSD/PA&E have undertaken an analysis to (1) quantify the benefits and risks of the focused logistics concept, (2) assess current analytic tools, (3) identify future needs to model and analyze the effect of logistics on combat, (4) explore conceptual frameworks for modeling logistics and (5) develop recommendations for the representation of logistics in the Joint Warfighting System (JWARS). The analysis employs a number of modeling tools, to include Tactical Warfare model (TACWAR), Vector in Commander (VIC), Knowledge-Based Logistics Planning Shell (KBLPS), and Enhanced Logistics Intratheater Support Tool (ELIST). This presentation will address interim results of the analysis, capabilities and shortfalls of models currently available, and key challenges in data development.

WG19 – LOGISTICS, RELIABILITY & MAINTAINABILITY (LOGRAM) - Agenda

Chair: LTC Charles H. Shaw, III (USA); U.S. Naval Postgraduate School (NPS)
Co-chairs: Mr. Gary Arnett; Synergy, Inc.
Mr. Dennis Collins; Reserve Component Automation System (RCAS) Office
MAJ Dave Kunzman (USMC); HQMC, I&L
Advisor: Dr. William "Max" Woods; U.S. Naval Postgraduate School (NPS

Room: I-263

Tuesday, 23 June 1998, 1030-1200

COMPOSITE GROUP D SESSION .... Room G-109

Tuesday, 23 June 1998, 1330-1500 *Welcome and Emerging Technologies/Methodologies*

Welcome, Introductions, and Administrative Requirements

Modeling Using Dynamic Network Algorithms
Mr. Lawrence G. Fess, Mr. J. Curtis Badgett, and Mr. Robert Taft, Joint Warfare Analysis Center (JWAC)

Applying Reactive TABU Search to Routing Supply Vehicles at a Defense Distribution Depot
Dr. J. Wesley Barnes, Professor, Graduate Program in Operations Research and Mr. Charles F. Myers, Defense Logistics Agency

Using a "Blue Force" Knowledge Based Logistics Planning System (KBLPS) to Examine "Red Force" Logistics
Mr. John Grabfelder, Military Logistics Branch Chief

Wednesday, 24 June 1998, 0830-1000 *Special Operations Forces (SOF) Logistics (Joint w/WG 16)*

Joint Session with WG 16 .... Room I-122

Overview of SOF Logistics Modeling and Analysis in Support of U.S. Special Operations Command (USSOCOM)
LTC Charles Shaw, III (USA), NPS, Department of Operations Research, Code OR/SC

Modeling Logistics in Full Spectrum Operations/Military Operations Other Than War (FSO/MOOTW)
LT Jeff D. Goodmanson (USN) (possibly presented by LTC Charles Shaw, NPS)

Logistics Planning Factors for Special Operations Forces (SOF) Logistics Modeling and Analysis
CDR Michael Giancatarino (USN) for NAVSPECWARCOM, LT Timothy Lanquist (USN) for USASOC, and LT Brett Wagner (USN) for USAFSOC

Wednesday, 24 June 1998, 1030-1200 *Outsourcing and Commercial Support*

Using the Balanced Scorecard to Manage Outsourcing and Reengineering Initiatives
Mr. Henry J. Kostanski, Operations Research Analyst, Defense Logistics Agency

Reliability Measurement in "Best Commercial Practices" for Acquisition
Mr. Dennis Collins, USA Project Management Office and Mr. Mark K. Sawatzki, Boeing Information Services

Developing a Model of Commercial Readiness: Conventional and Non-conventional Threats
Mr. Walter Estrada and Mr. Tom McIlvain, TASC

Wednesday, 24 June 1998, 1330-1500 *Distribution and Infrastructure*

Joint Sizing Study for Time Definite Commercial Air Sustainment
Mr. David De Haan, Dynamics Research Corporation

Transportation/Distribution Infrastructure Assessment
Mr. David A. Horner, Mr. Bill Willoughby, and Ms. Niki C. Deliman, USA Engineer Waterways Experiment Station
U.S. Geotechnical Laboratory, Mobility Systems Division (MSD)

Thursday, 25 June 1998, 0830-1000 *Supply Systems*

Customer Focused Metrics & the Supply Challenge, A Systems Dynamics Approach
Eleanor Winn Reid, Operations Research Analyst, Defense Logistics Agency

Using Logistic Response Time (LRT) Effectively in Supply Chain Management
MS. Anne Hale, Analyst, Logistics Management Institute (LMI)

Economic Retention Policy for Repair Parts
Mr. Tovey Bachman, Research Fellow, Logistics Management Institute (LMI)

Thursday, 25 June 1998, 1030-1200 - Wholesale, Installation, and Depot Maintenance
The Impact of Depot Workload on Readiness
Mr. David Mortin and Ms. Maria Zmurkewycz, U.S. Army Materiel Systems Analysis Activity (USAMSAA)

Centralized Multi-Period Depot Level Maintenance Planning for U.S. Marine Corps Ground Equipment
Capt. Chris Goodhart (USMC), HQMC

Use of Physics of Failure to Promote Commercial Technology Insertion and Reduce Sustainment Costs
Mr. Thomas Stadterman, Mr. Randy Wheeler, Ms. Jane Krolewski, and Mr. Barry Hum, U.S. Army Materiel Systems Analysis Activity

Thursday, 25 June 1998, 1330-1500 *Aviation Reliability and Maintenance Activities*
Cycle Time Reduction to Improve Naval Aviation Readiness Using Modeling and Simulation
RADM Donald R. Eaton (Ret), Dr. Keebom Kang, LCDR Kevin Mooney (USN), and LCDR Guy Sanchez (USN), NPS, Department of systems Management

Alternative Assessment for an Aircraft Maintenance Process Using Simulation Modeling and Response Surface Analysis
Lt Col J. O. Miller (USAF) and Maj W. Paul Murdock (USAF), Air Force Institute of Technology and Capt Timothy E. Smetek (USAF) National Air Intelligence Center

Input Data Characterization Factors Affecting Availability Estimation Accuracy
Dr. Edward F. Mykytka and Maj Edward A. Pohl (USAF), Air Force Institute of Technology and Maj Darren P. Durkee (USAF) Air Force Studies and Analysis Agency

WG19 – LOGISTICS, RELIABILITY & MAINTAINABILITY – Abstracts
Room: I-263

Tuesday, 1030 - 1200
COMPOSITE GROUP D SESSION.. Room G-109

Tuesday, 23 June 1998, 1330-1500
Modeling Using Dynamic Network Algorithms

Mr. Lawrence G. Fess, Mr. J. Curtis Badgett, and Mr. Robert Taft
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Many military problems involve moving people, equipment, materiel, or all of the above in the shortest possible time(quickest transshipment) or within a specified time/required date (dynamic transshipment). Recently, an algorithm has been published by Mr. Bruce Hoppe to solve these problems in strongly polynomial time using "Dynamic networks". JWAC is currently implementing this algorithm as one basic model underlying our network analysis for military applications.

The advantages to using dynamic network flows are: a) for multiple time periods, the network representation does not have to be duplicated for each time periodas with traditional network formulations, b) the run time is proportional to log (T) rather than T allowing model granularity increases in similar solution times, and c) a better representation of the network is achieved since the traversal times of arcs are directly represented in the network and intermediate nodes are not created. Examples will be provided along with computational results.

Applying Reactive TABU Search to Routing Supply Vehicles at a Defense Distribution Depot

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Approved abstract unavailable at printing.

Using a "Blue Force" Knowledge Based Logistics Planning System (KBLPS) to Examine "Red Force" Logistics

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Wednesday, 24 June 1998, 0830-1000

Joint Session with WG 16 .... Room G-102

Overview of SOF Logistics Modeling and Analysis in Support of U.S. Special Operations Command (USSOCOM)

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Modeling Logistics in Full Spectrum Operations/Military Operations Other Than War (FSO/MOOTW)

LT Jeff D. Goodmanson (USN) (possibly presented by LTC Charles Shaw, NPS)
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Because the nature of FSO/MOOTW which most often involve Special Operations Forces (SOF) are significantly different than traditional combat missions, the simulation and analysis of these topics lag far behind combat modeling. In the area of logistics, this is particularly true since even traditional combat models lack sufficient logistics planning and analysis tools. The purpose of this study is to support the efforts of USPACOM in development of logistics and mobility planning tools for FSO/MOOTW in particular and SOF in general. A large body of work has been completed on planning and analysis tools for U.S. military forces. However, the nature of FSO/MOOTW has driven a requirement for tools that would include non-U.S./Allied military, inter-agency, and non-military personnel as well as their logistics assets and non-traditional material.

The first step to accomplish this is to define an FSO.MOOTW logistically. The variety of missions that are defined under this term mean there are a wide variety of participants and some missions may overlap. This often depends on the perspective of the particular CINC. The next step is to conduct a survey of existing models in all services that perform logistics functions. From this survey, it can be determined where some methods or fuctionality may be useful to modeling a FSO/MOOTW scenario. The data necessary to develop a model and the sources, U.S. and non-U.S., must also be determined. The study will not present a model, but rather a design architecture for follow-up efforts in modeling FSO/MOOTW.

Logistics Planning Factors for Special Operations Forces (SOF) Logistics Modeling and Analysis

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United States Special Operations Forces (SOF) are the most highly trained and well-equipped forces in the world. Although this statement is without question true, there are certain capabilities they are lacking in. The most visible and most overlooked is logistics. Under Title 10 each service must provide logistic support to its Special Operations Force regardless of operating environment.

Currently, there are no SOF unique planning factors available that can help logistics planners in their assessment of SOF logistics requirements. Current estimates are made using Army Light Infantry unit planning factors. Although these are sufficient in over-estimating most classes of supply, they do not take into account SOF unique items. Since there is no data currently available on actual SOF consumption rates, assumptions had to be made and conclusions had to be verified by the Commander in Chief, United States Special Operations CommandÆs operational and logistics planners.

Logistics support for SOF units is primarily tasked organized. In order to develop the most efficient way to support single-service and joint SOF units, a baseline logistics support structure had to be developed for each service. Once developed., the baseline forces could be modified and integrated to support any combination of forces during a given mission profile.

Efforts are underway to integrate the three services logistics planning factors and support unit structures into a logistics planning tool for use by joint and component SOF logistics planners. The primary purpose of the planning tool will be to help logistics planners reduce the logistics footprint in theater while maintaining adequate logistics support to all units. Integration of this planning tool into future combat models may help to justify the need for a Joint Special Operations Logistics Command or other joint logistics infrastructure.

Wednesday, 24 June 1998, 1030-1200
Using the Balanced Scorecard to Manage Outsourcing and Reengineering Initiatives

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The great majority of DLA s expenses consist of purchases of materiel and services from commercial sources. These outsourced services include such things as supplies, equipment , maintenance, rents and utilities. To manage the complex relationships involved with this level of outsourcing activity a single integrated tool was needed. The balanced scorecard proved to be such a tool. The balanced scorecard is in use throughout private industry where it is providing a framework for strategic management of many phases of business operations.

Reliability Measurement in "Best Commercial Practices" for Acquisition

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The Department of Defense (DOD) Series 5000 regulations require the use of "Best Commercial Practices" in acquisition in lieu of more stylized and expensive traditional methods like the Reliability and Maintainability process which generates a discrete Operational Availability requirement. During the summer of 1995, the Reserve Component Automation System was restructured, in part to comply with the DOD 5000 series regulations. As a result, the resources available to manage and measure system and component reliability were dramatically reduced.

The need to measure reliability remains, however, in cases where the end user perceives that hardware quality is inadequate, or there is a need to evaluate competing hardware vendors. An expectation that automation hardware reliability could be measured against readily available manufacturer mean-time-between-failure (MTBF) estimates has proven impractical. Unprecedented increases in automation technology have shortened the life cycle of automation hardware to months, and sometimes weeks, making the collection of field data for the reliability of commercial off-the-shelf products.

Developing a Model of Commercial Readiness: Conventional and Non-conventional Threats

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Approved abstract unavailable at printing.

Wednesday, 24 June 1998, 1330-1500
Joint Sizing Study for Time Definite Commercial Air Sustainment

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During Operations Desert Storm/Desert Shield (DS/DS), the United States Transportation Command (USTRANSCOM) and its air component, Military Airlift Command (now Air Mobility Command or AMC) developed an express air cargo system to handle the U.S. Central Command's warstopper requirements and patterned it after commercial carrier's express service. This system was commonly referred to as Desert Express (DE). Based on the successes of DE, AMC developed a concept to contract out the consolidation of the cargo shipments from AMC customers to a commercial cargo carrier's facility. This concept is now known as Air Mobility eXpress (AMX) and will provide joint wartime time-definite CONUS-to-theater delivery of high priority cargo. AMX would take advantage of commercially developed systems and facilities, eliminating a step performed during DE operations.

This study builds upon the results of a similar study conducted by Dynamics Research Corporation (DRC) in September 1996 to define the US Air Force Time Definite Air Sustainment requirements. (Presented MORSS 97)
The purpose of this analysis is to determine comprehensive sizing data for the three remaining Military Services (USA, USN, USMC) and to consolidate this data with the sizing data from the previous USAF study in order to determine the total assets required to support wartime operations and to provide contractual strategies.

Transportation/Distribution Infrastructure Assessment

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The Transportation Infrastructure Assessment Module (TIAM) is being developed by the U.S. Army Engineer Waterways Experiment Station (WES) as the prototype general engineering component of the Engineer Operations system (EOPS) with a specific focus on the engineer interface with logistics, distribution, and transportation systems and operations. The TIAM is designed as a decision support tool in analyzing distribution networks during planning for initial usage, sustainment maintenance, and rebuild phases for the distribution network. Support for military sustainment operations, especially engineering support, within an operational theater are provided by the following capabilities in TIAM: 1) evaluation of the impact of environmental factors on the maximum throughput along selected routes, 2) identification of potential logistics support areas or locations, 30 estimation of road life based on expected or actual traffic flow, and 4) analysis of engineer work effort required to maintain and repair routes. The purpose of the presentation is to discuss TIAM functions, applications, and enhancements.

Thursday, 25 June 1998, 0830-1000
Customer Focused Metrics & the Supply Challenge, A Systems Dynamics Approach

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This paper discusses the dynamic orientation to this topic that has been taken by the Defense Logistics Agency decision-makers in determining how best to invest dollars on critical weapons system parts. An agreed upon set of measures is needed so that DLA and its customers are monitoring complimentary areas. This includes the DLA's use of internal metrics for Agency processes that are consistent with the external customer metrics. This dual tracking on metrics is needed to properly shape policy decisions that will result in enhanced customer support.

Both the internal structure of the support system and the external end-item applications cause the logistics system to behave in a certain way. Therefore, we must monitor and evaluate the key critical complexities to fully understand how to improve the system. Through the use of "Systems Dynamics", DLA will be able to provide both the military end-user and the internal Agency process owner with insight on how to enhance supply performance. This enhanced supply performance will be able to positively impact customer metrics that are significant to the end-user. It is only through Systems Dynamics approach that the DLA customer support process can be understood and improved.

This presentation will address the several essential elements to Systems Dynamics required to make this process function effectively: feedback thinking, loop dominance and nonlinearity, endogenous point of view, systems structure, levels and rates. The ultimate goal of the Systems Dynamics approach is to connect system structure with dynamic behavior. Through the Systems Dynamics approach, DLA is able to model internal Agency process metrics to pinpoint where resources need to be allocated in order to modify outcomes.

Using Logistic Response Time (LRT) Effectively in Supply Chain Management

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LRT is the time from when a customer requisitions an item until the time when the customer receives the item. LRT serves as a direct link to weapon-system readiness which is defined as uptime/(uptime + downtime). Not only is LRT a performance measure, it can also serve as a planning metric to influence resource procurement and allocation decisions. To effectively use LRT, the services need a system for measuring it and processes that apply it in inventory investment, allocation, and planning.

In particular, full use of LRT in the business processes results in:

- The "best" mix and allocation of inventory within the wholesale and retail requirements determination process.
- The "best" reliability and maintainability (R&M) solution from the logistic support and engineering analysis processes.
- The desired return-on-investment from proposed alternative support strategies involving non-organic support options such as direct vendor delivery, premium transportation, commercial and non-developmental item logistic support, and fleet management.

LRT also plays a part in readiness assessment and risk management. As a primary input parameter to readiness assessment and business process reengineering tools, LRT provides a means to evaluate alternative logistic strategies to see if they meet goals and satisfy funding or operational constraints before they are implemented. Once implemented, the strategies can be monitored with LRT values to manage the risk to readiness if these values deviate beyond the tolerable limits.

This paper quantifies the benefit of managing with LRT in terms of reduced inventory cost and/or improved readiness for a weapon system.

Economic Retention Policy for Repair Parts

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Once purchased, stock should be disposed of only if the savings in retention cost—primarily for warehouse space—and revenue from disposal exceed the probable cost of repurchasing it later to meet new customer demand. We propose a new method for deriving economic retention levels that better balances these costs.

Item demand histories are used to compute empirical probabilities of depleting candidate retention levels in various amounts of time. We use these probabilities to estimate the repurchase cost associated with each of several candidate retention levels. Disposal cost, the difference between repurchase cost and revenue from disposal, is then compared to estimated retention cost. The economic retention level is the candidate level for which these costs are most nearly equal.

For items with demand frequent enough to forecast, we found that the retention level should be based on the demand frequency in the forecast base period. For items with more sporadic demand, we found it best to base retention levels on the item's price.

Thursday, 25 June 1998, 1030-1200

The Impact of Depot Workload on Readiness

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In this time of shrinking budgets, Army decision makers are interested in knowing what impact depot workload changes will have on weapon system readiness. This study demonstrated that because of supply positions and current high weapon system readiness rates , there appear to be no immediate readiness impacts in peacetime from increases or decreases in repair times for components. However, if repair programs were totally cut, the Army does not have sufficient inventory to prevent readiness from quickly degrading for some systems. This study also found that money is being spent for depot repairs of components, which are excess to requirements. Depot workload changes, related to repair of end items, have a more direct impact on weapon system readiness. Additionally, past studies have shown that reliability centered repairs have improved weapon system reliability and reduced future repair costs.

Centralized Multi-Period Depot Level Maintenance Planning for U.S. Marine Corps Ground Equipment

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The Marine Corps builds multi-period, depot-level maintenance schedules and budgets for over 150 major types of ground equipment. The objective is to maintain the highest possible level of equipment readiness (measured in terms of numbers of assets available for use) while showing how that readiness can be achieved by adhering to the proposed itemized budgets. A dynamic model is being developed for use at the Service headquarters level to build multi-period repair lists and itemized budgets by maximizing utility of the corresponding mixes of serviceable equipment. The model balances flow of resources (serviceable or unserviceable assets) from one period to the next and is constrained primarily by available budget totals and minimum required numbers of serviceable assets by type. It uses existing reliability data to project unserviceable returns to the depots; these projections may be replaced in the model's near-term periods with planned quantities developed at maintenance conferences. Results desired from the model also include quantification and measurement of the risks to equipment readiness associated with diminishing budgets for depot-level repair.

Use of Physics of Failure to Promote Commercial Technology Insertion and Reduce Sustainment Costs

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This paper presents two physics-of-failure reliability assessment case studies on electronic circuit card assemblies (CCAs). For the first case study, CCAs in the tri-service ARC-210 radio were analyzed to predict potential failure mechanisms. Accelerated life testing was conducted on the CCAs and verified the physics-of-failure analysis. A point of interest is that this CCA had previously undergone traditional reliability testing and no problems were found. The significant logistics impact of this failure mechanism is highlighted. For the second case study, commercial CCAs in the Bradley Fire Support Team (BFIST) vehicle were analyzed to determine if the military environment would cause failures in the useful life of the system.

Both case studies concentrated on board-level failure mechanisms because these are most likely to cause failures in commercial CCAs in a military environment. The University of Maryland Electronic Packaging Research Center's CalcePWA software was used to perform vibration, thermal, and failure mechanism analyses. CalcePWA was used to calculate times-to-failure for each failure mechanism.

These case studies show that physics of failure allows informed decisions on the impact of electronic design on reliability and logistics. By performing these analyses, the ARC-210 radio's reliability was increased and the BFIST program's confidence in using commercial electronics was increased. The increase of reliability and the use of commercial electronics has greatly reduce the sustainment costs of these systems.

Thursday, 25 June 1998, 1330-1500

Cycle Time Reduction to Improve Naval Aviation Readiness Using Modeling and Simulation

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The ultimate goal of DoD logistics is to maintain the highest level of military readiness, which is commonly defined by the fraction of time that the weapon system is up or mission capable. Two key issues to improve weapon systems readiness are reliability improvement and cycle-time reduction. Cycle time reduction in the DoD logistics channel (military depots, intermediate-level maintenance, inventory control points, supply centers, etc.) reduces the number of weapons systems and components in the repair pipeline, making more weapon systems available at the fleets/fields, resulting not only in higher readiness, but also in cost savings. We have developed a simulation model to improve component repair processes at Naval Aviation Depot North Island, and evaluated several proposed enhancements in component repair processes using the model. These enhancements could substantially reduce repair cycle time and pipeline inventory, resulting in cost savings and eventually higher Naval Aviation readiness.

Alternative Assessment for an Aircraft Maintenance Process Using Simulation Modeling and Response Surface Analysis

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Input Data Characterization Factors Affecting Availability Estimation Accuracy

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Reliability analysts are often faced with the challenge of characterizing the behavior of system components based on limited data. Any insight into which input data is most significant and how much data is necessary to achieve the desired accuracy requirements will improve the efficiency and cost effectiveness of the data collection and data characterization process. This research assesses potential significant factors in the probabilistic characterization of component failure and repair behavior with respect to the effect on system availability estimates. Potential factors were screened for significance utilizing a Plackett-Burman experimental design for several system models developed using an AFOTEC simulation program entitled RAPTOR.

WG 20 – MANPOWER AND PERSONNEL – Agenda

Chair: Mr. Herbert J. Shukiar, RAND
Cochair: Capt. Edward T. Dewald, USMC
Cochair: LTC Steve Galing, US Army
Cochair: Maj. Tom Garin, USAF
Cochair: CDR Mike Mara, USN
Cochair: LCDR Paul Soutter, USN
Advisor: Dr. Harry Thie, RAND

Room: I-267

Tuesday, 1030 - 1200
COMPOSITE GROUP D SESSION .... Room G-109

Tuesday, 1330-1500
Building the Army's Future Manpower Forecasting Models
CPT(P) John R. Crino, US Army DCS Personnel (Strength Analysis and Forecasting Division)

Tree-Based Methods for Forecasting Retention Rates
Pr. Harold J. Larson and Pr. Samuel Buttrey, Operations Research Department, Naval Postgraduate School

Enhancements to the Officer Forecasting System
Pr. Siriphong (Toi) Lawphongpanich, ODCSPER Chair for Manpower Modeling at Naval Postgraduate School
CPT John L. Thurman, US Army DCS Personnel (Strength Analysis and Forecasting Division)

Modernizing the Army's Civilian Personnel Forecasting System (CIVFORS)
Richard Shaffer, GRC International

Wednesday, 0830-1000
Moving Toward Performance-Based Enlistment Standards
Dr. Edward Schmitz and Ms. Andrea Zucker, Navy Recruiting Command

Reducing Attrition through Policy Adjustment
Dr. Edward Schmitz and Mr. Don Bohn, Navy Recruiting Command

Recruiter Refresher Training Evaluation
LCDR Paul Soutter and Mr. Rudy Sladyk, Navy Recruiting Command

The USAREC Delayed Entry Program Risk Analysis Program (DEPRAP)
CPT John Jessup and Mr. Kevin Lyman, U.S. Army Recruiting Command

Wednesday, 1030-1200
Aircrew Manning and Experience Levels, Mission Scope and Peacetime Operations Affect Operational Training Resource Requirements
W. W. Taylor and S. C. Moore, RAND

Stochastic Analysis for Deployments and Excursions (SADE)
Patrick J. DuBois, LTC, PhD, US Army Concept Analysis Agency

The Response of Aviation Training Costs to Changes in the Requirement for Aviators
Dr. Henry L Eskew, Center for Naval Analyses

TRADOC Acquisition Manpower Requirements Study
Robert J. Stevens, Headquarters, U.S. Army Training and Doctrine Command

Wednesday, 1330-1500
Military Recruiting Incentives Effectiveness
Ms. Claudia Beach, U.S. Army Recruiting Command

An Enlistment Bonus Allocation Model
MAJ Jeff Joles, MAJ Steve Charbonneau and Donald R. Barr, US Military Academy

Enhancing the Army's Recruit Assignment System
Dr. Peter M. Greenston, US Army Research Institute

Optimizing United States Marine Corps Enlisted Assignments
Brian F. Tivnan, Capt, OR Master's student, Robert Dell, Associate Professor, Naval Postgraduate School

Thursday, 0830-1000
The Effect of Desert Storm on Reserve Component Enlisted Retention
Sheila Nataraj Kirby and Scott Naftel, RAND

Reassigning Marine Corps Reservists to Improve Readiness.
Jeremy L. Leiby, Midn 1/C, USNA Mathematics student, Mike Shehan, Major, USMC, Master Instructor, and Thomas J. Sanders, Professor, United States Naval Academy

New Opportunities for Military Women: Effects on Readiness, Cohesion, and Morale
Margaret Harrell and Laura L. Miller, RAND

PERSTEMPO and Quality of Life in the Air Force
Maj Robert J. Nuanes, Ken G. McNeil and Capt Mark R. Grabau, Air Force Studies and Analysis Agency

Thursday, 1030-1200
Reengineering the Officer Personnel Management System for the 21st Century: Methodology and Family of Models.
LTC Michael McGinnis, Rhett Hernandez, Hugh Hoffman, Paul Thorton and Robert Phelan, TRAC-Monterey

Community-Specific Optimum Force
Paul F. Hogan and Pat Mackin, The Lewin Group

Personnel Synchronization Plan for the Army After Next
Major Michael Stehlik, Office of the Chief of Staff, Army, Directorate of Program Analysis and Evaluation

Analyzing Changing Occupational Structure
Joseph A. Colosi, US Central Intelligence Agency

Thursday, 1330-1500
Air Force ROTC 2000 Study
Douglas S. Hager, Lt Col, USAF, AF Officer Accession and Training Schools and James K. Lowe, Lt Col (ret), USAF and Harry N. Newton, Maj, USAF, United States Air Force Academy

Using Simulation to Model Time Utilization of Army Recruiters

1Lt James D. Cordeiro, 2Lt Mark Friend, Dr. Kenneth Bauer, Lt. Col. J. O. Miller and LTC Jack Kloeber
Air Force Institute of Technology

Using USAREC's Recruiter Workflow Simulation Model for Benchmarking and Operational Analysis
LTC Gregory C. Hoscheit, U.S. Army Recruiting Command

Locating Recruiting Stations for Competing Services
Pr. Kevin R. Gue, PhD, Department of Systems Management, Naval Postgraduate School

WG 20 - MANPOWER AND PERSONNEL- Abstracts
Room: I-267

Tuesday, 1030 - 1200
COMPOSITE GROUP D SESSION... Room G-109

Tuesday, 1330-1500
Building the Army's Future Manpower Forecasting Models

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The Army Strength Analysis and Forecasting Division in ODCSPER is currently redesigning its legacy manpower forecasting models. The Strength Management System Redesign (SMSR) mission is to create a forecasting system that will serve the Army's manpower forecasting requirements into the 21st Century. The new system will increase analyst productivity, decrease operation and maintenance costs, and increase forecasting accuracy. This brief presents the issues involved with reviewing the forecasting modeling methodologies, determining hardware and software platforms, and defining functional and non-functional requirements that ensure the system is state of the art and flexible enough to accommodate future technological advances.

Tree-Based Methods for Forecasting Retention Rates

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The Army has for many years used a strength management system that relies in part on the division of recruits into Characteristic Groups (C-Groups). These groupings, which have never changed, categorize first-term enlisted personnel according to sex, education, AFQT group, and term of service. They were originally designed to identify differences in first-term retention behavior, which in turn should increase the accuracy of future projected retention rates. (Predictions for homogeneous groups are less variable than predictions for heterogeneous groups.) In recent years, though, the retention rates for these C-Groups have differed very little.

Our research describes a new set of C-groups, based on mostly the same sets of measurements, that are different from one another and therefore of more use in forecasting. We use Classification and Regression Trees, a relatively recent statistical technique that assigns a measure of "purity" (homogeneity in terms of the predilection to complete the first term of service) to a set of recruits. That set is then divided into two non-overlapping subsets, based on the measurements we have, to produce the purest possible subsets. So, for example, a group might be divided into men and women; high-school graduates and non-graduates; or whatever division results in the greatest purity. These subsets are themselves divided in turn; this process continues until some stopping criterion is met. The result is a set of criteria that, it is hoped, divide the recruits into C-groups which are as "pure" as possible and as different from one another as possible.

Enhancements to the Officer Forecasting System

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The Military Strength Analysis and Forecasting Division of ODCSPER, HQDA has been working for the past year through GRC International's System Solutions Group to enhance the current officer forecasting model. The Officer Projection Aggregate Level System (OPALS), a mainframe optimization model developed in the mid 1980s, had been modified in 1995 to provide quicker turn around time and greater analytical freedom by moving it to run on the PC. The new model, the Officer Aggregate Analysis Tool (OAAT), was written in AMPL Plus using a CPLEX solver. In 1996, within the context of the redesign of the ODCSPER forecasting system, the decision was made to reformulate the model into a generalized network with side constraints. The new system uses the 32-bit version of AMPL Plus that pulls and writes its data from an Oracle database on the ODCSPER network. This brief will cover the formulation of the model, initial results of testing and use, and some of the lessons learned from a user's perspective.

Modernizing the Army's Civilian Personnel Forecasting System (CIVFORS)

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GRC International has, over the past year, reengineered the Army's Civilian Personnel Forecasting System from a single software (PL/1) shared mainframe environment to a more open, client-server environment emphasizing portability, accessibility, and user control of system operation. The new system extends the capability of the legacy CIVFORS by providing: the graphical user interface for accessing, visualizing, sharing and administering projection data; an enhanced optimization component written in AMPL (A Mathematical Programming Language) and using CPLEX's advanced mathematical programming software for Windows NT; relational database management using Oracle 7.33, increasing data availability by an order of magnitude; and compatibility with Microsoft Office products such as Excel and Word.

Wednesday, 0830-1000

Moving Toward Performance-Based Enlistment Standards

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The Navy currently adheres to a very strict definition of recruit "quality". However, recently the recruiting environment has become much more challenging and the Naval Force is entering an era of recruiting to a steady state, rather than downsizing. Navy must reassess past and current assumptions and test options for recruiting in today's challenging environment.

This paper addresses one option that both expands the recruiting market and improves job performance. By enlisting high school graduates who score below the current minimum on their entrance exam, but score above average on qualification scores for a particular job, the Navy can accomplish these goals. Almost a quarter of this potential pool qualifies with above average job qualification scores. This group also has low attrition, and remedial classes which currently exist can help to make up their shortfall in their entrance exam score. This pool of potential recruits can increase in-service performance at no additional recruiting costs. We examine the pros and cons of moving to such a performance-based rather than IQ-based enlistment standard.

Reducing Attrition through Policy Adjustment

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Each year Navy Recruiting Command must find nearly sixty thousand youths interested in enlisting in the Navy. However, there are losses throughout the pipeline: from joining the Delayed Entry Program (DEP) through boot camp and "A" school training to the end of the first term of service. This attrition is very costly in terms of wasted effort on the part of the recruiters, who then have to make up the losses with new recruits. Furthermore, attrition in this portion of the pipeline has increased dramatically since 1991.

This paper examines factors related to attrition and how changes in policy can help reduce attrition. We concentrate on attrition from the DEP and boot camp, where our policies can have more of an impact. We look at how earlier drug testing and more rigorous background checks affect attrition, either reducing it or identifying at an earlier, less costly stage. We also investigate how the personal behavior of recruits (their exercise habits and whether they smoke) relates to attrition and how policies encouraging physical training in the DEP or smoking cessation programs in the DEP could help reduce attrition.

Recruiter Refresher Training Evaluation

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There is continuing emphasis in the commercial and government sectors on using comprehensive measurement and evaluation processes to determine the return on investment for training. Not unlike a private company with a large sales force, the Navy utilizes a refresher training program to enhance recruiter performance. In order to measure the effectiveness of this training, a results-based training evaluation model was designed and implemented.

This paper traces the development of the Navy's results-based training evaluation model from identifying the purposes of the evaluation and choosing an evaluation method to analyzing and interpreting the data and calculating return on investment. The model estimates the training related performance improvement by class and by recruiter category and also estimates the duration of improved performance.

The USAREC Delayed Entry Program Risk Analysis Program (DEPRAP)

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One of the U.S. Army Recruiting Command's highest priorities is determining how to keep recruits from failing to fulfill their contractual obligations. Each year USAREC loses approximately 17% of all contracts to what is known as delayed entry program (DEP) Loss. We developed DEPRAP to determine the likelihood any applicant has of being a DEP Loss. DEPRAP is based upon a mathematical examination of key factors into DEP loss using SPSS software known as Chi-squared Automatic Interaction Detector (CHAID). After analyzing the applicant database of over 70 characteristics, we found that 13 characteristics could determine the likelihood that a prospect would be a DEP loss. The predictive nature of these characteristics was validated and verified via a trial and error sorting process using CHAID. Using the results of CHAID, we wrote a number of FOXPRO programs that assigns a risk factor (percent likelihood of being a DEP Loss) to each applicant entering the Army. This risk factor is appended to the command's main database, which can be viewed by every recruiter. Additionally, we are working on a DEP Risk Analyzer that will allow the recruiter or leader to input the characteristics of the prospect or applicant and receive the likelihood that this person will be a DEP loss. By knowing the risk factor, recruiters will be able to closely monitor those applicants with high risk and take the necessary actions to avoid a DEP Loss. We are also developing a Commander's Barometer, which will give the commander a "barometer" of how healthy his or her DEP pool is. By effectively using these tools, recruiters and leaders have the resources to effectively manage their DEP members, avoid DEP Losses, and save the Army millions of dollars on lost training slots. This presentation will cover the factors into a DEP Loss, and the tools we are developing to assist recruiters in managing their DEP pools.

Wednesday, 1030-1200

Aircrew Manning and Experience Levels, Mission Scope and Peacetime Operations Affect Operational Training Resource Requirements

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We describe a new linear programming model that identifies efficient quantities of training sorties and other training resources to provide fighter squadrons' aircrews the skills that underlie different mission capabilities. Inputs include required mission capabilities and associated skill requirements, unit manpower levels (distinguishing experience levels and jobs--e.g., wingmen, flight leaders, and instructors, and pilots versus weapon-system officers--within a squadron), personnel turnover rates (reflected in aircrew upgrade requirements), alternative types and versions of training activities (two- or four-aircraft air combat tactics training missions, operating with versus without opposition, at home base versus at an exercise, daylight versus at night, etc.), and associated resources(e.g., sorties, flying hours, opposing aircraft, refueling,

range/airspace requirements). The optimization recognizes interdependencies in unit members' training (e.g., upgrade trainees must fly certain missions with instructors, and wingmen must fly with flight leaders) and that different training activities contribute to different skills and, hence, to different operational capabilities. We illustrate the model's use for assessing different experience mixes, crew ratios, capability requirements, squadron sizes, and levels of support for peacekeeping/making operations.

Stochastic Analysis for Deployments and Excursions (SADE)

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The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of the events to which the United States (US) commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily commits to Major Theater Wars (MTW) and Small Scale Contingencies (SSC). These types of operations occur increasingly more often and with much more uncertainty concerning event inter-arrival, duration, and the number/type of troops/equipment required. Due to recurring demands to justify force structure, the focus change and the increase in uncertainty inherent with these new types of operations, there is a need to forecast the number and type of operations the US Military will have to respond to simultaneously.

This paper discusses a methodology that is based on queuing theory and incorporates stochastic processes (simulation) using the simulation software AWESIM" to forecast the number of SSCs (by type) that the US Military could be involved in during the period 1998 to 2006. Although the methodology has many benefits, possibly the biggest may be its ability to estimate the distribution of the occurrence of simultaneous SSC operations. These estimates can be used to evaluate the risk associated with unit availability based on a given resourced force structure, as well as the development of requirements in the force structure development process. The methodology is described and results shown.

The Response of Aviation Training Costs to Changes in the Requirement for Aviators

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This presentation describes an analysis that sought to answer the following question: What is the change in the annual costs of undergraduate naval aviation training associated with a unit change in the requirement for operational aviators? The analysis used the historical Future Years Defense Program as its primary database. No cost distinction was made among strike pilots, maritime pilots, rotary pilots, and navigators/naval flight officers. The final estimate, $72 thousand in fiscal 1997 prices, included both a military personnel and an operation and maintenance component. These results have been incorporated into the Navy's Cost of Manpower Estimating Tools (COMET) information system.

TRADOC Acquisition Manpower Requirements Study

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The Acquisition Manpower Requirements study effort at HQ TRADOC develops and applies an analytical methodology for estimating future manpower requirements of TRADOC's Directorate of Contracting (DOC) offices. The methodology provides for the collection and validation of functional data; the conduct of statistical analyses of manpower and functional data to determine the statistical significance of hypothesized relationships; the development of a computerized interactive model to estimate future manpower requirements; and the execution of the model based on the decision maker's policy preferences.

Manpower and functional data are collected for five fiscal years. Authorizations, the dependent variable, represents manpower. The number of contract actions and dollar obligations, the independent variables, represent the functional data. Furthermore, the obligation data is stratified by Total, On-Loads, Mission, and BASE Operations (BASOPS) support. Using the five year historical base, statistical relationships

are examined between the manpower and functional variables, including the stratification of the obligation data. Linear and second-order polynomial relationships emerged as having the best statistical significance.

An interactive computer model is developed for the decision maker to estimate Directorate of Contracting authorizations based on current or future contract obligations. As the decision maker begins to make manpower reductions, the graphical interface shows the impact of those reductions. The decision maker can ameliorate this impact by setting floors to authorizations and obligations or making an upper or lower adjustment to any of DOC's estimated authorizations. Furthermore, the decision maker can see in other charts the potential risk of those reductions.

Wednesday, 1330-1500

Military Recruiting Incentives Effectiveness

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When it was first instituted in 1982, the Army College Fund was unique among the military service incentives. All other services offered the Veterans Education Assistance Program, followed, in 1985, by the Montgomery G.I. Bill. But, based on the results of an incentive experiment, the Army College Fund was designed to give the Army a competitive edge over the other services. Now, thirteen years later, two of the other three services also have a college fund incentive. This presentation outlines results of a study, which used an innovative technique, choice based conjoint analysis, to address the service college fund competition situation. Choice based conjoint analysis indirectly assesses complex multi-attribute trade-offs in a realistic competitive context. This indirect approach allows determination of sensitivity to alternative product features, brands (service) prices, and product modifications that can affect market share. Continuation of the research will determine attribute trade-off relationships between military services and other civilian opportunities.

An Enlistment Bonus Allocation Model

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The US Army Recruiting Command (USAREC) has completed a survey of potential recruits, using a market research approach known as "choice-based conjoint analysis". One product of this work is a set of utilities that can be used to estimate relative proportions of the target population that would choose each of certain offered incentive packages. Incentives considered include bonus awards, length of commitment, military occupational specialty (MOS) and payment of college loans. We report results of a study sponsored by USAREC aimed at exploiting utilities from conjoint analysis to optimally determine the Army's recruiting bonus structure. We demonstrate use of integer programming techniques to determine optimal bonus "packages" for a set of MOS categories and present an example suggesting the feasibility of this approach.

Enhancing the Army's Recruit Assignment System

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The Army's Recruiting Quota System, known as REQUEST, assigns applicants to jobs based on meeting minimum qualifications and current job-fill requirements. REQUEST does not attempt to assign would-be recruits into jobs for which they would be most productive. It does not (and cannot) discriminate among applicants who range from least to most qualified. In addition, it does not consider future recruit supply when assigning recruits to near-term versus future seats. In sum, the existing classification procedure virtually ignores differential abilities and the dynamic aspect of allocation.

To address such shortcomings the Army Research Institute (ARI) has sponsored research to improve the selection, classification, and utilization of enlisted personnel, and this led to development of a prototype Enlisted Personnel Allocation System (EPAS). Prototype testing has been completed recently, and the project is moving toward implementation. Testing has shown that large gains in (recruit) mean predicted performance, on the order of 0.25 to 0.50 standard deviation units, can be obtained. Achievement of such gains, using existing procedures, would be prohibitively expensive.

Designed to enhance REQUEST by introducing optimization into what is a sequential process, EPAS models the assignment process as two phases. In the first phase, a large linear programming (LP) model is formulated to represent the monthly flow of applicants and training class seats over the recruiting business cycle. The model is solved for the allocation of (applicant) supply groups to job training starts that maximizes recruit predicted performance while meeting training management goals. The LP model solution is updated weekly and used to generate an ordered list of job recommendations particular to each supply group. In the second phase of individual applicant assignment, these recommendations are merged with those generated by existing procedures and presented to the applicant.

Optimizing United States Marine Corps Enlisted Assignments

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We present a mixed integer linear program to assist the Manpower division of Headquarters, United States Marine Corps, accomplish its mission: to put the right Marine in the right place at the right time with the right skills and quality of life. The program optimizes the by-name assignments of enlisted Marines to several complex requirements on a monthly basis. Currently, the Marine Corps enlisted assignments are made through a time intensive manual process; enlisted monitors, senior non-commissioned officers operating in their respective military occupational specialties, sort through several data fields to match individual Marines to fluid monthly requirements. The developed mixed integer linear program automates the majority of the assignments allowing the monitors additional time for exceptional cases. The program is designed to assist the monitors in their mission, not replace them. Computational results will be provided.

Thursday, 0830-1000

The Effect of Desert Storm on Reserve Component Enlisted Retention

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The reserve components played a major part in Operation Desert Storm (ODS) and have participated in all major deployments since then. Thus, it is important to know how mobilizations affect retention. However, opinion on this effect divides sharply. Some argue that mobilizations and the attendant financial and familial hardships drive people out of the reserve components. Others hold that the opportunity to practice skills won through years of training and to serve the nation actually foster retention. This paper examines the effect of being mobilized on retention decisions of first-term and mid-career enlisted personnel, using data from the 1991 Survey of Mobilized and Non-mobilized Reservists. The analyses strongly suggest that being mobilized to participate in ODS had little adverse effect on retention. Nor did loss of income or increased expenses caused by the call-up. But there is an important caveat regarding the generalizability of these results to more frequent small-scale mobilizations that are perhaps unpopular. The increased operations tempo experienced by the reserve components in recent years requires careful watching to ensure that possible adverse effects on reservists and their families are mitigated.
Reassigning Marine Corps Reservists to Improve Readiness.

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We present a linear model using an assignment approach to help the Marine Corps Reserves better assign reservists to units in a geographical area. The area used in the example given is Southern California. The Marine Corps has over 40 reserve units in this area. Some units are over manned while others are undermanned. If a unit is too drastically undermanned it cannot perform its mission and cannot be deployed operationally. The problem we are addressing is how to reassign and/or retrain the current population of reservists in Southern

California to achieve a minimum of 90% manning in as many units as possible. Reservists are recruited and receive Marine Occupational Specialty (MOS) training for specific billets at specific reserve units. Before being accepted for training in a particular MOS, a Marine must score above a certain level on a standardized test. The different MOSs and the corresponding test scores are determining factors on how a Marine can be reassigned. Other factors considered include the distance between the unit and the Marine's home, the Marine's current rank and MOS, and the cost of retraining a Marine for a different MOS. Computational results will be provided.

New Opportunities for Military Women: Effects on Readiness, Cohesion, and Morale

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The number of women in the armed forces surged with the establishment of the all-volunteer force. With this increase came pressure to open more units and career fields to women. Between 1992 and 1994, legislative and policy changes were made to increase opportunities for women. A recent RAND document, "New Opportunities for Military Women: Effects on Readiness, Cohesion, and Morale," examines the progress of the services in expanding opportunities for women and the effect of that expansion on the readiness, cohesion and morale of selected units. This work concludes that, overall, women can serve in a much wider range of units and career fields than they could in 1993 but that sharp differences exist among services. Furthermore, although integration of women does have a small effect on readiness, cohesion and morale; leadership, training and the unit workload are perceived as having a far more profound influence.

PERSTEMPO and Quality of Life in the Air Force

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In 1997, the Air Force Personnel Center developed a database to track temporary duties (TDYs) of Air Force personnel. Also in 1997, the CSAF directed two surveys called the Climate Survey and the Quality of Life Survey. This study aggregates the database reports and the surveys' results into statistical information relating the PERSTEMPO of the Air Force to the Air Force's quality of life.

Thursday, 1030-1200

Reengineering the Officer Personnel Management System for the 21st Century: Methodology and Family of Models.

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In June 1996, the Army Chief of Staff, General Dennis J. Reimer, convened a task force called the Officer Personnel Management System (OPMS) XXI Task Force. The objective was to review and update as necessary the current OPMS. The Task Force was also to ensure the system continued to develop officers capable of meeting military challenges confronting our nation in a changing world. Therefore, while OPMS XXI addressed concerns of the Army today, it also addressed concerns in the context of building an officer corps for meeting the challenges of the 21st Century-from Army XXI to Army After Next. This paper describes the methodology used by the Task Force in their efforts to reengineer the OPMS. The family of military personnel models used for analyzing OPMS XXI alternatives is also discussed.

Community-Specific Optimum Force

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Approved abstract unavailable at printing.

Personnel Synchronization Plan for the Army After Next

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The Army is embarking on a major restructuring endeavor as it seeks to bring Force XXI into place over the next decade and then the Army After Next circa 2025. Each of these forces will increasingly rely on technology to thin the fog of war and increase the tempo of operations and lethality of the future battlefield.

Implicit in the Army's overall restructuring process is the Army's ability to continue to attract the people necessary to bring each of these armies to fruition. In other words, it is a "build it and they will come" view of the future engendered by the unimaginable success of the All Volunteer Army.

However, the Army ended FY97 in a very difficult personnel posture, as did the other Services, with no readily robust explanation as to why. This analysis explores many trends in America's civil and military societies as they holistically may affect American's decision to serve in the military to explain the current, and more importantly, future manning problems facing the Army.

Today, there is no long range process which synchronizes and aids our understanding of the disparate types of data associated with future personnel. The Personnel Synchronization Plan is such a process. It was developed from the Army's Intelligence Preparation of the Battlefield as a process specifically designed to "thin the fog" of future personnel.

Analyzing Changing Occupational Structure

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In an environment of declining budgets, rapidly changing technologies, and shifting national security objectives, the occupational structure of intelligence agencies that resulted from the buildup of the 1980s might not meet needs projected for the next decade. This paper presents a stochastic EXCEL model used to project the occupational structure of the major components of an intelligence agency over a five-year period. The work force in each component is disaggregated into component-specified occupational groups--each subject to annual attrition, occupational shifts, and changes in status based on recent historical rates that are modified for age structure and expected changes in relevant personnel policies.

Where component group work force targets are available, deficits or surpluses (potential gain or loss requirements) are estimated for each group as the difference between the targets and model-projected group strength. Hires and separations being costly, the SOLVER feature of EXCEL is used to find the set of group reassignment rates that minimizes projected total component occupational deficits and surpluses at the end of the five-year period. The optimal rates are constrained by recent historical experience and limits on the share of group strength that can be reassigned or absorbed in any one year. Alternatively, SOLVER can be used to solve the model for the minimum cost of achieving component occupational targets, given hiring and separating costs and constraints and costs associated with reassignments between specific pairs of occupational groups. Application of the model to related work force problems is explored.

Thursday, 1330-1500

Air Force ROTC 2000 Study

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This study provides a method of evaluating ROTC detachments performance in the wake of changes to ROTC production goals and an Air Staff

mandate to reduce AFROTC detachment manning by five percent. The study also provides the viability assessment of each ROTC detachment required by DODD 1215.8.

To assess the performance of each detachment relative to other detachments, we developed a Value-Focused Thinking (VFT) model with metrics for the number, types, and quality of officers produced. We propose an optimization model to simultaneously consider constraints based on Air Force and AFOATS policy goals, production targets, and manpower limits. The optimization model maximizes the sum of the scores of the detachments left open.

Using Simulation to Model Time Utilization of Army Recruiters

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It is a well-known fact that Army recruiters work very long hours in a demanding environment. The job itself demands self-starting, motivated individuals who require a wide range of skills, from street-savvy to salesmanship, in order to succeed. A number of factors in recent years has made military recruiting more difficult, such as scandals involving highly-placed soldiers to changes in attitudes towards military service amongst eligible youngsters. Added to the mix is a recent mission increase which has exacerbated this problem even further. Unlike previous studies which have concentrated on the effects of advertisements and other determinants of enlistments in the Army, this study focuses on the individual recruiters themselves, with the ultimate purpose of defining the relationship between the various recruiter tasks and the end product--qualified Army recruits.

The key step towards the accomplishment of this goal was the determination of which factors influence recruiter effectiveness. In the course of developing a model and subsequent computer simulation of the recruiting process, a thorough process flow description of the major recruiter tasks was generated. Task completion times were estimated on the basis of empirical studies of actual recruiting stations in anticipation of their use as model input parameters. All of this information was then incorporated into working SIMPROCESS and ModSim computer simulations of a single recruiting station with an arbitrary number of recruiters. Finally, sensitivity analysis of recruiter output with respect to various input parameters was accomplished.

Using USAREC's Recruiter Workflow Simulation Model for Benchmarking and Operational Analysis

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Locating Recruiting Stations for Competing Services

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Military services locate recruiting stations to attract the highest number of recruits with the fewest stations and recruiters. Each service strives to locate stations close to areas with the most potential recruits, but other services have the same objective, and their presence in a market reduces expected production.

Location decisions are complicated by opposing notions of interaction with other services. On the one hand, a service is competing for the same recruits as other services, and so has incentive to locate stations away from competing stations. On the other, it can reduce facility costs by collocating with competing stations, thus allowing more resources to be spent on recruiters, advertising, or additional facilities. The problem is similar to that faced by the holding company of competing fast-food restaurants, which can reduce advertising and management expenses by collocating stores from competing chains, although collocation reduces the expected revenue from those stores.

We describe a model that locates recruiting stations for multiple, competing services at minimum cost to the Department of Defense, subject to the service achieving established production targets. The optimization model embodies a non-linear econometric model of recruit production that uses detailed zip-code level data such as population and geographic area. Location decisions are modeled with integer variables, resulting in a mixed integer, non-linear problem. We decompose the problem according to a scheme developed by Lawphongpanich, Rosenthal and Schwartz, and show how the presence of competing stations affects location decisions for services in a typical recruiting region.

WG21 - READINESS - Agenda

Chair: Jack Leather, Defense Manpower Data Center/TREAD
Cochair: Scott Flood, Chief of Naval Operations (N81)
Cochair: Duane Pace, Defense Manpower Data Center/TREAD
Advisor: Joseph Angello, ODUSD(R)(RP&A)

Room: I – 369

Tuesday, 1030-1200
Advisor Opening Remarks
Mr. Joseph Angello, ODUSD(R)(RP&A)

A New Paradigm for Measuring Military Readiness
Dr. John F. Raffensperger, Naval Postgraduate School

Tuesday, 1330-1500
Predicting Readiness: Why Is It So Difficult?
Mr. Scott R. Flood, Office of the Chief of Naval Operations (N-81)

Predicting Readiness: Feasibility and Importance
Dr. Jim Jondrow, Dr. Peter Francis, Dr. Bob Trost and Ms. Darlene Stafford, Center for Naval Analyses

Managing Readiness
Dr. Laura Junor, Dr. Jim Jondrow and Dr. Peter Francis, Center for Naval Analyses

Wednesday, 0830-1000
The Relationship Between Spending and Readiness for DoD
Dr. Stanley A. Horowitz and Ms. Maria Borga, Institute for Defense Analyses

Emerging Tools for Analyzing and Forecasting Readiness
Dr. B. Charles Tatum, Navy Personnel Research and Development Center

Joint Training and Collective Performance Measures: Validating the Process Through Measurement
Dr. Carol Johnson, Defense Manpower Data Center; Mr. Robert Fleming and Mr. Joseph C. Barto, III, Camber Corporation

Wednesday, 1030-1200
Application of Dynamic Readiness to the Reserve Component
Mr. John R. Brinkerhoff, Institute for Defense Analyses

Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats
Mr. Walter Estrada and Dr. Tom McIlvain, TASC

Wednesday, 1330-1500
COMPOSITE GROUP E SESSION .... Room I-122

Thursday, 0830-1000
Impact of Peace Operations Deployments on USAF Aircraft Combat Skills
Mr. John Stillion, RAND

Personnel Synchronization Plan for the Army After Next
Major Mike Stehlik, Office of the Chief of Staff of the Army, Directorate of Program Analysis and Evaluation

Quantitative Analysis of the Utility of Antipersonnel Landmines (APL)
Colonel Forest Crain, U.S. Army Concepts Analysis Agency

Thursday, 1030-1200
Impacts of Depot Workload Reduction on Readiness
Ms. Maria Zmurkewycz and Mr. David Morton, U.S. Army Material Systems Analysis Activity

WG 21 – READINESS – Abstracts
Room: I - 369

Tuesday, 1030-1200
A New Paradigm for Measuring Military Readiness

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Current measures of military readiness are inadequate. Their only incentive is "more is better". They are subject to gaming between subordinates and superiors. They can mislead planners even when they are accurate. They do not tell precisely when a unit can be ready nor do they tell which units to send to a conflict. They give no information about how much readiness we can buy with another dollar.

We propose a new paradigm with the potential to give robust readiness information. Our methods rely heavily on operations research analysis.

Readiness of a small unit such as a tank battalion or a Navy ship should be measured by its *train-up time*, the number of days required to prepare for war, if the unit were mobilized. For the case of a tank battalion, we developed an algorithm to create peacetime and go-to-war training schedules to calculate train-up time optimally. The model also determines the change in train-up time for a change in the peacetime budget – the *marginal cost of readiness*.

Readiness of a large unit such as an Army division should be measured with respect to a specific mission or set of (possibly stochastic) missions. The marginal cost of readiness as calculated for each unit becomes the objective function coefficients in a model that assigns units to missions at minimum cost. Thus readiness for a large unit may be measured in *dollars*.

Finally, we propose a model of cyclic readiness that may be used to *prescribe* optimal levels of readiness.

Tuesday, 1330-1500
Predicting Readiness: Why Is It So Difficult?

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When the post Cold War downsizing began in the early 1990's, the senior leadership in the U.S. military became concerned that the severe cuts to the defense budget would return the military to a status similar to the hollow force of the late 1970's. Because of this, readiness began to receive much more attention. Readiness information was generated and began to flow upward to the highest levels of each of the services, culminating in a quarterly meeting of the Senior Readiness Oversight Council (SROC).

As readiness received increased visibility and its measurement became more popular, the next logical step was to use known information and attempt to forecast readiness. The intent was to be able to make policy and/or resourcing decisions without adversely affecting readiness *too* much. Over the years, different methods were developed, including, but not limited to, principal component analysis and time series regression, but all met with limited success. Many other efforts are currently underway to try to refine and expand the task of predicting readiness.

This paper will discuss a brief history of the measurement of readiness, some of the predictive methods attempted, and offer some insights as to why these predictive efforts only enjoyed a modicum of prosperity. Then, it will attempt to delve into the core of the problem of predicting readiness, examining the intricacies that make it difficult to achieve. Finally, it will offer suggestions to focus further efforts into this solving this perplexing issue.

Predicting Readiness: Feasibility and Importance

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Because of the widespread interest in predictive readiness, it is worthwhile asking how important is prediction in making decisions. This brief considers one particular decision: how to maximize readiness given a particular readiness budget. It shows that an optimal decision does not necessarily depend on the accuracy of the forecast of readiness.

Managing Readiness

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Managers have repeatedly asked for tools that would alert them to an impending decline in readiness. To date, research has indicated that accurate forecasts of readiness more than a few months into the future are not possible. Forecasts, however, are not the only, or necessarily the best, tools for managing readiness. This brief discusses three general approaches that can be used by managers and the pros and cons of their corresponding tools. Tools discussed include quality control, statistical models, benchmarking, and inventory models.

Wednesday, 0830-1000

The Relationship Between Spending and Readiness for DoD

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Previous analysis has shown that as force size has fallen over the last decade or so, spending on the direct support of combat forces has fallen slightly more than proportionately. This paper examines how the magnitude of the reduction in readiness-related spending (for a given force size) affects the reported readiness of combat forces. First, an expected level of readiness-related funding is derived based on the number of active duty personnel in a particular year. This is compared with the actual level of readiness-related funding. The difference between the two is used to predict the fraction of units in the highest readiness categories. A highly significant and quantitatively important relationship is found for DoD as a whole.

Emerging Tools for Analyzing and Forecasting Readiness

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The definition and measurement of readiness is an important topic in today's military establishment as noted in several recent reports (Congressional Budget Office [CBO], 1994; Defense Science Board [DSB], 1994; General Accounting Office [GAO], 1994a, 1994b; Moore, Stockfisch, Goldberg, Holroyd & Hildebrandt, 1991; Tatum, Laabs, & Nebeker, 1998). The purpose of this presentation is to discuss the general concept of readiness and suggest some new analytical tools for predicting readiness and relating resources to readiness. The first part of the presentation argues that readiness (and sustainability) are critical components of the broader notion of military capability, and both involve issues related to deployment and battle performance. It will be noted that several things make readiness difficult to analyze: (a) there are many factors that influence readiness, (b) data on deployment and battle performance are low quality and difficult to obtain, and (c) readiness is measured at many levels (e.g., individual, team, unit). The second part of the presentation will focus on three analytical tools (structural equation modeling, artificial neural networks, and multilevel analysis) for forecasting readiness and relating resources to readiness. The discussion of these tools will focus on the advantages of each for addressing different problems in accurately measuring and predicting readiness. The presentation will conclude with a report on recent progress at the Navy Personnel Research and Development Center in understanding readiness using these three analytic tools.

Joint Training and Collective Performance Measures: Validating the Process through Measurement.

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As a result of the 1992 Joint Training Review, the CJCS directed that the Joint Staff develop and institutionalize a requirements based training system to better focus DoD's training resources and return a better trained and more ready Joint Force. The first step was to define the capabilities required in terms of Task, Conditions, and Standards using the Universal Joint Task List (UJTL). Ideally, joint training should use the Joint Training System (JTS) process to translate missions to capability requirements using the UJTL. Once requirements are defined, training objectives are developed and events designed to accomplish those objectives. This process provides focus and discipline to the planning, execution and evaluation of events and will provide performance data to assess mission readiness.

A tremendous amount of energy has been invested to implement the system and the resource expenditure must be justified in terms of increased organizational performance. Organizational performance in DoD is measured in terms of readiness. The JTS is based on an analytical process of translating missions capability requirements to tasks, conditions, and standards, and then to training objectives. Training objectives describe the level to which *people* must *perform* to accomplish the task. Consequently, the ability to measure the organizational performance of the tasks is essential.

This paper lays the analytical framework and reviews the research on collective performance measurement. It challenges the MORS community to conduct a review of the performance measurements in the UJTL to determine the sufficiency of those measures identified and make recommendations for new measurements.

Wednesday, 1030-1200

Application of Dynamic Readiness to the Reserve Component

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Readiness is most often considered a static quality of a military member, unit, or force. Yet, readiness can also be addressed as a dynamic process in which prearranged or impromptu measures are taken to make them ready to conduct military operations. In this construct, the current readiness state is viewed as a starting point for remedial actions that are taken rapidly when an individual, unit, or force is alerted for employment in a military operation. Dynamic readiness is quite different from programmatic readiness, in which actions are taken over the long term to increase (or decrease) at a future time the allowable initial states of military members, units, or forces. Programmatic readiness moves slowly by adjusting funds or asset authorizations to change the peacetime condition of a member, unit, or force. Dynamic readiness moves rapidly to bring a member, unit, or force to the desired (or design) state believed necessary to permit effective participation in military operations. Dynamic readiness allows the DoD to incorporate actions to improve readiness in contingency plans to conduct or support contemplated military operations. This paper will define readiness in terms of a time-line from current state to immediate pre-employment state and define dynamic readiness as the process of doing that. The measure of goodness of dynamic readiness measures is the extent to which they can shorten the time it takes for a member, unit, or force to get ready to do its job. While Dynamic Readiness applies to all forces, it is particularly important to RC forces, for which the time it takes to get ready is both critical and controversial.

Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats

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As DoD budgets decline, depots are closed, and forces are reduced, the warfighter's reliance on large DoD inventories must be replaced by greater dependency on direct commercial supply sources. In this new environment, full war/contingency materiel support readiness assessment can no longer be considered complete or realistic unless it includes an assessment of commercial sources.

In addition, future scenarios are more likely to involve non-conventional threats, such as nuclear, biological, and chemical (NBC) weapons. As so-called Weapons of Mass of Destruction, their name suggests a potential reality, that these weapons can produce large numbers of casualties in a single attack. The numbers of casualties produced may significantly strain the medical logistics system over and above conventional plans. This will raise new issues of medical resource forecasting.

To address these challenges, the TASC team is developing a fully threaded rapid supply support readiness assessment and planning capability. This includes the ability to forecast with greater accuracy the future materiel states of the commercial base and its correlated ability to support warfighter needs ("commercial readiness"). To address NBC, we plan to integrate an NBC medical logistics planning model into our current commercial readiness demonstration.

Wednesday, 1330-1500

COMPOSITE GROUP E SESSION .... Room I-122

Thursday, 0830-1000

Impact of Peace Operations Deployments on USAF Aircrew Combat Skills

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The primary purpose of this study is to develop a better understanding of how peace operations deployments impact individual fighter aircrew air-to-ground and air-to-air combat skills. Through the use of statistical controls, it will analyze data on the number and type of training events USAF aircrew accomplish at home station and when deployed in support of ongoing peace operations over Bosnia and Iraq. This analysis should shed light on the relationship between factors such as aircrew experience, recent practice and combat skill performance and reacquisition.

Understanding these relationships is important in any attempt to better quantify the true cost of USAF involvement in peace operations and can also help determine how large a premium the USAF should place on aircrew experience. A better understanding of the relationship between experience, recent practice and combat skill performance could be of importance in determining the optimum length of Air Expeditionary Force deployments to areas where training is significantly degraded relative to home station, better predictions of how long returning units need to recover lost combat skill proficiency, and could eventually lead to a "training event based" rather than an "hours based" or "sortie based" system for measuring aircrew experience and individual and unit combat readiness levels.

Personnel Synchronization Plan for the Army After Next

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The Army is embarking on a major restructuring endeavor as it seeks to bring Force XXI into place over the next decade and then the Army After Next circa 2025. Each of these forces will increasingly rely on technology to thin the fog of war, increase the tempo of operations and lethality of the future battlefield.

Implicit in the Army's overall restructuring process is it will continue to attract the people necessary to bring each of these armies to fruition. In other words, it is a "build it and they will come" view of the future engendered by the unimaginable success of the All Volunteer Army.

However, the Army ended FY97 in a very difficult personnel posture as did the other Services with no readily robust explanation as to why.

This analysis explores many trends in America's civil and military societies as they holistically may affect American's decision to serve in the military to explain the current, and more importantly, future manning problems facing the Army.

Today, there is no long range process which synchronizes and aids our understanding of the disparate types of data associated with future personnel. The Personnel Synchronization Plan is such a process. It was developed from the Army's Intelligence Preparation of the Battlefield as a process specifically designed to "thin the fog" of future personnel.

Quantitative Analysis of the Utility of Antipersonnel Landmines (APL)

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This effort provides analysis to quantify the military utility of antipersonnel land mine use and assisted the Army in identifying/assessing doctrine and tactics-based alternatives to mines. This response to the Office of the Secretary of Defense concluded that banning APLs would significantly impact force effectiveness and the ability to achieve military objectives. Results from three separate theater simulations using Concepts Evaluation Model (CEM) were corroborated with findings from pervious tactical level analysis using EAGLE and JANUS.

Measures of Effectiveness used were: whether or not campaign objectives were met; time required to halt the enemy attack; depth of enemy penetration into friendly territory; fractional exchange ratio (FER); major weapon system losses; and personnel casualties. Force alternatives examined included artillery and multiple launch rocket systems (MLRS), attack helicopters, close air support (CAS), and maneuver units. The findings from this analysis influenced Presidential policy on U.S. participation in the proposed ban on APLs.

Thursday, 1030-1200

Impacts of Depot Workload Reduction on Readiness

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In this time of shrinking budgets, Army decision makers are interested in knowing what impact depot workload changes will have on weapon system readiness. This study demonstrated that because of supply positions and current high weapon system readiness rates , there appear to be no immediate readiness impacts in peacetime from increases or decreases in repair times for components. However, if repair programs were totally cut, the Army does not have sufficient inventory to prevent readiness from quickly degrading for some systems. This study also found that money is being spent for depot repairs of components, which are excess to requirements. Depot workload changes, related to repair of end items, have a more direct impact on weapon system readiness. Additionally, past studies have shown that reliability centered repairs have improved weapon system reliability and reduced future repair costs.

WG 22 – ANALYTIC SUPPORT TO TRAINING - Agenda

Chair: Mr. Brian R. McEnany, Science Applications International Corporation, PP
Cochair: Dr. Angelo Mirabella, Army Research Institute
Cochair: LTC Henry Coble, Joint Staff, J7/Training and Exercises
Cochair: Mr. Randy Oser, Naval Air Warfare Center Simulation and Training Division
Advisor: Mr. Michael Parmentier, Director (Readiness and Training) OUSD (R)
Room: I-325

Tuesday, 1030-1200 INTRODUCTION AND JOINT TRAINING SUPPORT
The Joint Simulation System (JSIMS) An Overview
Dr. David R. Pratt and CAPT Drew W. Beasley, USN, JSIMS Joint Program Office

Joint Exercise Management Program (JEMP) III: Future Management of Joint Training
Dr. Michael Wagner, Dynamics Research Corporation and Dr. David Promisel, U.S. Army Research Laboratory, HRED

Coherent Defense 97--A Benchmark For Joint Force Integration
Dr. Frank E. Schwamb, Joint Training Directorate (J7), United States Atlantic Command

Tuesday, 1330-1500 JOINT TRAINING AND AAR
Lessons Learned in Developing STOW-97 AAR
Jesse Aronson andTom Radgowski, Science Applications International Corp.

Assessment of the Military Utility of STOW-97
Steve Karppi and Dennis Shea, Center For Naval Analyses

Data Collection, Management and Analysis in Computer Assisted and Master Scenario Events List Exercises.
Joe J. Puckett, Warrior Preparation Center

Wednesday, 0830-1000 MEASURING JOINT TRAINING
Joint Training and Collective Performance Measures: Validating the Process through Measurement
Dr. Carol Johnson, Defense Manpower Data Center/TREAD; Robert Fleming and Joseph C. Barto, III

Analytic Model for Deriving Joint Service Training Measures and Training Guides
Douglas Dressel and Douglas Macpherson, U.S. Army Research Institute for the Behavioral and Social Sciences; James Love, LTC (Ret.), Consultant

Deriving Process Measures from the Universal Joint Task List (UJTL) to Support Feedback
Randy L. Oser, J. W. Gualtieri, J. A. Cannon-Bowers, Naval Air Warfare Center Training Systems Division

Wednesday,1030-1200 INDIVIDUAL TRAINING SUPPORT
Advanced Distributed Learning Initiative: Collaborating on a Common Technical Framework for Future Learning
Michael Parmentier, OUSD(R), Readiness and Training

Sustaining Foreign Language Skills: Assessment of a Deployable Language Tutor
Jonathan D. Kaplan, Robert A. Wisher , Robert J. Seidel, Mark A Sabol, US Army Research Institute

Impact of Peace Operations Deployments on USAF Aircrew Combat Skills
John Stillion, RAND Graduate School for Policy Analysis

Wednesday, 1330-1500
COMPOSITE GROUP E SESSION .... Room I-122

Thursday, 0830-1000 COLLECTIVE TRAINING SUPPORT
The Army's Training Mix Model
Philipp A. Djang and Richard R. Laferriere, US Army TRADOC Analysis Center - White Sands Missile Range, NM

Development of a Performance Assessment Package for DIVARTY Staff Training
Dr. Jennifer E. Fowlkes, Summit Technologies; Michael R. McCluskey, Dr. Daniel J. Dwyer , Naval Air Warfare Center Training System Division; Dr. Linda G. Pierce, USAFAS Field Element, Fort Sill, OK

ASW Proficiency Measures
Michael E. McDevitt, Kapos Associates, Inc. and Capt James Snyder, Fleet Anti-Submarine Warfare Training Center

Considering Organizational Learning at Military Microworlds
Dr. Michael Proctor, UCF and Major Justin Gubler, U.S. Army, Ft. Leavenworth, KS

Thursday, 1030-1200 MODELING COLLECTIVE TRAINING
The Utility of Modeling and Simulation in Fleet Training
Charles D. Carey and Tom Reid, Kapos Associates, Inc.

Development of a HLA, PC-based High-resolution, Constructive Combat Simulation
MAJs Gerald M. Pearman , Bill Murphy, Leroy Jackson, CPT Jeff Huisingh, LTC Mike McGinnis, TRADOC Analysis Center - Monterey

Linkage of Constructive Analytical Models to C4I Systems
Stanley C. Ritter and Keith Ramsey, US Army TRADOC Analysis Center, White Sands Missile Range

Simulation Support for Land Warrior
SFC Cary Augustine, TRADOC Analysis Center, Monterey

Thursday, 1330-1500 COLLECTIVE TRAINING SUPPORT
A Framework for Assessing Value Added of New Training Technologies
Dr. Richard Christ, US ARI Office, Digital Force Coordination Cell, Ft Hood

Expected Effects of Force Modernization on Exercise Control and Feedback in Live Simulation Exercises
Larry Meliza, ARI Simulator Systems Research Unit, Orlando; Bill Brown, John Nordyuke, Derick Gerlock, Ira Begley, LB&M Associates

A Methodology for Assessing Knowledge Organization in Teams: Implications for Training Design
James W. Gualtieri, Naval Air Warfare Center Training Systems Division; John J. Burns, Sonalysts, Inc.;
Linda G. Pierce, Army Research Laboratory Human Research & Engineering Directorate

WG 22 - ANALYTIC SUPPORT TO TRAINING –Abstracts
Room: I-325

Tuesday, 1030-1200 - INTRODUCTION AND JOINT TRAINING SUPPORT
The Joint Simulation System (JSIMS) An Overview

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The Joint Simulation System (JSIMS) is the flagship program of the next generation of constructive models. JSIMS is a single, seamlessly integrated simulation environment. It includes core infrastructure and mission space objects, both maintained in a common repository. These can be composed to create a simulation capability to support joint or service training, rehearsal, or education objectives. In this paper, we will present the program background, overarching requirements, development methodology, and program implications.

The goals of JSIMS are intrinsically ambitious. After the first phase of development, or Initial Operational Capability (IOC) in 1999, JSIMS must replace the functionality of the Joint Training Confederation (JTC), increase the fidelity of joint service training, significantly reduce exercise support resources, and interact with the user via their real-world Command, Control, Communication, Computers, and Intelligence (C^4I) systems. The next phase of development, which will lead to Full Operational Capability (FOC) in 2003, will expand the capabilities of the IOC system. It will include the ability to resolve down to the platform level, support development of new doctrine and tactics, provide a mission rehearsal capability, facilitate linkages with other models, and support for a wide range of military operations.

Historically, models designed for training have also been used for analyses. Thus, a dialogue between the analytic community and the JSIMS Joint Program Office (JPO) is highly encouraged. An understanding of the JSIMS program structure and goals by the operations research community is apt to provide better tool selection for future analytic needs.

Joint Exercise Management Program (JEMP) III: Future Management of Joint Training

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The Joint Staff (J-7) and the Joint Warfighting Center are implementing a process by which joint force commanders analyze their missions and establish mission requirements. These requirements provide the basis of planning, conducting, and evaluating joint training. The main advantage of this requirements-based system is that the planning, conducting, and evaluating of training activities can all be keyed to the mission that the armed forces are organized to execute.

The transition to requirements-based joint training also offers a numbers of opportunities to change the way that we manage joint training. For example, if OPLANs for missions are represented in the requirements phase, these same mission OPLANs can be used to drive the development of realistic training plans, exercise scenarios, data collection plans, and tools for assessing training results. With the recent fielding of the JEMP III software release covering both the Requirements and Plans phases of the Joint Training System, the power of an integrated joint training management system can begin to be appreciated.

For example, the Plans phase of the JEMP III software stimulates the development of training plans by prompting the trainer with JMETL (including tasks, conditions, and standards), with potential training audiences (taken from mission OPLANs), and with assessment data on the ability of the potential training audiences to execute assigned tasks under realistic conditions and to the levels of performance consistent with OPLANs. This paper will describe the logic of the Joint Training System (JTS) automation and will demonstrate how the software will support commanders in their role as training managers.

Coherent Defense 97--A Benchmark for Joint Force Integration

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Coherent Defense 97 (CD97) was a U.S. Atlantic Command project to illuminate issues and resolve inter-Service friction points in Joint Theater Missile Defense (JTMD). The CD97 process for addressing troublesome issues in Joint Force Integration (JFI) has shown considerable strength. Coherent Defense was not the rule -- but the exception to the rule -- in achieving JFI. The normal processes of JFI and joint interoperability are either bottom-up melding of Service capabilities and development of Joint tactics, techniques and procedures (TTP) or top-down identification of operational requirements and synthesis of capabilities in the context of joint doctrine. When the normal processes do not work, extraordinary measures such as Coherent Defense provide a forum for the resolution of friction points.

Coherent Defense involved several critical steps:

- Issue selection by leadership.
- Issue clarification and refinement in a sequence of problem solving sessions.
- Deriving specific objectives for a demonstration.
- Planning a demonstration around specific objectives.
- Nailing down solutions in a demonstration.

This paper will provide details on the underlying issues, design of the guided seminars and demonstration exercise, and results of the exercise, and will describe the essential features of the CD process and its strengths and weaknesses as a means to resolve JFI issues.

Tuesday, 1330-1500 JOINT TRAINING AND AAR SUPPORT

Lessons Learned in Developing STOW-97 AAR

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In the training environment, After Action Review (AAR) systems form one of the critical links between simulation and training functions. AAR systems extract key elements from the synthetic battlespace, providing trainers and analysts with the information they require to guide and evaluate training. The goal of the Defense Advanced Research Projects Agency (DARPA) Synthetic Theater of War (STOW 97) Program was to extend the benefits of entity-based simulation to the conduct of Joint Task Force (JTF) training exercises for the United States Atlantic Command (USACOM).

During the Unified Endeavor (UE) 98-1 exercise , the STOW AAR system provided opportunities for trainers and analysts to examine events in the simulated battlespace at levels of detail not previously possible for JTF training exercises. This additional detail carried with it the risk of complicating the AAR process, e.g., the tremendous volume of information available within STOW had the potential to overwhelm analysis efforts. The challenge of the STOW AAR system was to provide the ability to access and "drill-down" into the full depth of STOW

simulation data in a way which enhanced, rather than hindered, the efficiency of training and analysis. This presentation provides an overview of the STOW 97 Advanced Concepts Technology Demonstration, describes the STOW AAR system, and explains how it was used to provide both quantitative and qualitative information in support of UE 98-1 training analysis.

Assessment of the Military Utility of STOW-97

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The technology of advanced distributed simulation holds promise to help the military services conduct their training more effectively and at lower cost. The Defense Research Projects Agency (DARPA) is supporting the development of this technology through programs such as the synthetic theater of war (STOW). STOW integrates recent developments in computer networking, computer-generated forces, environmental modeling, computer graphics, and simulation infrastructure to create a distributed synthetic environment for training and mission rehearsal. The most recent major test of the STOW technologies took place at U.S. Atlantic Command (USACOM) in October 1997 during an Advanced Concept Technology Demonstration (ACTD), designated STOW-97.

An essential component of the ACTD is an assessment of the military utility of STOW. That assessment will gauge whether the STOW technologies are on track to satisfy the requirements of operational users such as USACOM. USACOM J7 was the operational sponsor of the STOW-97 ACTD and conducted the assessment, assisted by the Center For Naval Analyses (CNA).

CNA developed a methodology, including several analysis techniques and corresponding measures of effectiveness (MOEs), to assess the effectiveness of STOW in supporting joint operational training. This paper discusses the results when we applied our methodology during the ACTD. Our work focuses on the Master Scenario Events (MSEL's), Requests For Information (RFI's) and other key stimuli in the demonstration, and analyzes how the additional detail provided by STOW can contribute to training a JTF staff. We also examined how the automated forces in STOW might reduce the number of support personnel currently required in a Unified Endeavor (UE) JTF exercise. Finally, we assessed STOW's computational requirements to simulate the number of forces typically employed in a UE exercise.

These results will help to identify those aspects of the STOW technologies that hold promise for JTF HQ training and should be transitioned to JCS-sponsored and service-specific simulation programs, such as JSIMS and WARSIM.

Data Collection, Management and Analysis in Computer Assisted and Master Scenario Events List Exercises.

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The brief provides a discussion on Computer Assisted Exercises (CAX) and Master Scenario Event List (MSEL) driven exercises, highlighting the fundamental design of each type of exercise and the principal interfaces between the main components. The brief transitions into a short summary of the basic structure of analysis for exercises at the Warrior Preparation Center in Einsiedlerhof, including examples of some of the products that are provided during an actual exercise. The brief then focuses on the Master Events Management System, a system which provides a tool to assist in the planning ,execution, and analysis of MSEL driven exercises. The Exercise Control Information Server (EXCIS)--an intranet which connects Exercise Control together with Analysis--is also discussed. Included in the discussion are examples of how this process was done in the past, recent exercises where both MEMS and EXCIS have been used, and future improvements planned for the system. The brief then presents a detailed look at the separate functions between the Joint Exercise Control Group (JECG) and the After Action Review Facilitator (AAR Facilitator) during exercises. Finally, the brief concludes with an example of how the two sources of data in an exercise (Observer-Controller data and Simulation data) can be merged and integrated and finally analyzed. The example given was an actual incident which occurred in exercise Union Flash 96 and was included in the After Action Review for that exercise.

Wednesday, 0830-1000 MEASURING JOINT TRAINING

Joint Training and Collective Performance Measures: Validating the Process through Measurement

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As a result of the Joint Training Review in 1992, the CJCS directed that the Joint Staff develop and institutionalize a mission focused, requirements based training system to better focus DOD's training resources and return a better trained and more ready Joint Force. The first step was to define the capabilities required given the full range of assigned missions in terms of Task, Conditions, and Standards using the Universal Joint Task List. Ideally, joint, combined, and interagency training should use the Joint Training System process to translate missions

to capability requirements using the UJTL. Once capability requirements are defined then the training objectives are developed and specific events designed to accomplish those objectives. This process provides focus and discipline to the planning, execution and evaluation of events conducted and will provide performance data to inform the commanders as they assess their mission readiness.

A tremendous amount of energy has been invested to implement and install the system and now the resource expenditure must be justified in terms of increased organizational performance. Organizational performance in the department of defense is measured in terms of readiness. The Joint Training System is based on an analytical process of translating missions capability requirements to tasks, conditions, and standards, and then to training objectives. Training objectives describe the level to which *people* must *perform* to accomplish the task. Consequently, the ability to measure the organizational performance of the tasks is essential.

This paper lays the analytical framework for collective performance measurement and reviews the current research on collective performance measurement. It challenges the MORS community to conduct a detailed review of the performance measurements in the UJTL to determine the sufficiency of those measures identified and make recommendations for new measurements.

Analytic Model for Deriving Joint Service Training Measures and Training Guides

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The increasing prevalence of mulitforce operations (multiservice, joint service, and multinational) has raised new challenges to assessing training performance to support after action reviews and readiness measurement. There is particular need to better understand how to train and evaluate the planning phases of both combat and peacekeeping operations at multiforce and other high echelons. An analytic model to address this need has been developed. A pilot test of the model has been conducted as part of a set of Air Operations training exercises (Blue Flag) commanded by a Joint Force Air Component Commander (JFACC). The methodology was given high marks by the staff of the host unit (9th Air Force). Further efforts to extend and test the model for training joint fires in a corps-level joint task force (JTF) training exercise are under way.

In the presentation to MORSS, we will describe the model and results of analytic applications to date. Briefly, the model begins with battle function analysis, then moves to derivation of joint training objectives, and culminates in the derivation of assessment instruments designed for use by the trainees. "Self assessment", is a key factor in this analytic approach. The approach is based on the notion that the trainees themselves have insights into training deficiencies, from a product and process perspective, which can critically supplement other sources of assessment data. We will also discuss evolving plans to test the latest version of the model for corps-level JTF exercises

Deriving Process Measures from the Universal Joint Task List (UJTL) to Support Feedback

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The Joint Training System (JTS) is a recent Joint-Service initiative that provides structure for planning, preparing, executing, and assessing Joint Training. A core component of the JTS is the Universal Joint Task List (UJTL) which provides detailed lists of tasks, conditions under which the tasks can be performed, and standards by which performance can be assessed. While the information documented in the UJTL is important, the standards focus on a single facet of measurement (i.e., outcomes). Effective learning environments require a multi-faceted approach to measuring performance and providing feedback.

An important characteristic of a multi-faceted approach to measurement requires the collection of data involving not just outcomes (i.e., was the right decision made?) but also processes (i.e., was the decision made right?). Process measures are particularly important for complex cognitive tasks which require situation assessment, decision making, and resource allocation. While outcome measures are critical for assessing overall performance, process measures are necessary for diagnosing specific deficiencies and providing feedback associated with how a given outcome was reached. In an effort to enhance the measurement strategy described in the JTS, a methodology for developing process measures from the UJTL was developed.

This paper will: (1) provide an overview of the Joint Training System, (2) describe a multi-faceted approach to measurement, (3) forward a methodology to derive process measures from existing UJTL documents, (4) provide an example of the methodology on UJTL tasks, and (5) describe future research requirements and application issues.

Wednesday, 1030-1200 INDIVIDUAL TRAINING SUPPORT
Advanced Distributed Learning Initiative: Collaborating on a Common Technical Framework for Future Learning

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The President has signed an Executive Memorandum directing the National Economic Council to develop a Federal Plan and a National Strategy for using learning technologies to improve education and training and to lower costs. Earlier the Secretary of Defense had directed the Department to find ways to develop a strategy for accelerating the application of learning technologies on a broad scale. The DoD's vision is to be able to ensure that its people have "access to the highest quality education and training, tailored to needs, wherever and whenever it is required." Efforts to achieve these goals resulted in the Advanced Distributed Learning (ADL) Initiative, which is DoD's vehicle for addressing its learning challenges. In developing ADL, however, it quickly became apparent that the guidelines and standards, implementing technologies, and learning objectives that serve DoD's needs are almost identical to those of other public government agencies and the private sector. Recognizing this commonality, the President's memorandum cited the Advanced Distributed Learning (ADL) Initiative as a model for both the Federal and National efforts. ADL brings together the military departments with the public and private sectors to develop a common technical framework based on several key elements, including:

- Widespread collaboration;
- Network technologies;
- Next-generation learning technologies; and
- Reusable content and object-based tools that are platform-independent.

Sustaining Foreign Language Skills: Assessment of a Deployable Language Tutor

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The sustainment of foreign language skills has been an enduring problem for global military readiness. In today's world, a working ability in many languages may be needed on short notice for a variety of missions. However, foreign language skills are notoriously perishable and maintaining proficiency in critical languages is difficult and costly. An underlying problem is that the 11,000 military linguists who need to sustain skills are scattered about the world, making centralized instruction not feasible. The Military Language Tutor (MILT) was designed as a deployable, PC based technological solution. MILT is a training technology that represents a revolutionary approach to sustaining communicative skills, liking emerging techno9logies from computational linguistics, computer science and speech recognition In MILT, students are given task relevant problem-solving exercises which allow them to use language products to manipulate a graphics micro-world. The manipulation of the graphics by successful language use is designed to be intrinsically rewarding, and thus motivating to use.

A field test was conducted with 167 Arabic-proficient member of the 5th Special Forces Group at Fort Campbell. Their proficiency in vocabulary, grammar, pronunciation, and overall fluency were measured, through blind evaluation by an Arabic linguist, before and after a micro-world exercise in which they sought the location of an chemical weapons facility. The results on instructional effectiveness indicated that all four dimension the rated translation score increased substantially. When these rating dimension were averaged, all by two of the sixteen subject showed statistically reliable improvement in rated translating skill as a result of using MILT.

Impact of Peace Operations Deployments on USAF Aircrew Combat Skills

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The primary purpose of this study is to develop a better understanding of how peace operations deployments impact individual fighter aircrew air-to-ground and air-to air combat skills. Through the use of statistical controls, it will analyze data on the number and type of training events USAF aircrew accomplish at home station and when deployed in support of ongoing peace operations over Bosnia and Iraq. This analysis should shed light on the relationship between factors such as aircrew experience, recent proactive and combat skill performance and reacquisition.

Understanding these relationships is important in any attempt to better quantify the true cost of USAF involvement in peace operations and can also help determine how large a premium the USAF should place on aircrew experience. A better understanding of the relationship between experience, recent practice and combat skill performance could be of importance in determining the optimum length of Air Expeditionary Force deployments to areas where training is significantly degraded relative to home station better predictions of how long returning units need to recover lost combat skill proficiency, and could eventually lead to a "training event based" rather than an "hours based" or "sortie based" system for measuring aircrew experience and individual and unit combat readiness levels.

Wednesday, 1330-1500

COMPOSITE GROUP E SESSION .... Room I-122

The Army's Training Mix Model

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We discuss the problem of constructing cost effective training strategies. We describe a mixed integer programming model and a method for estimating training effectiveness. The model is embodied in a Microsoft Windows program that removes the complexity of using mathematical programming and relational database software. In addition, we pose a problem to the working group: constructing an open method for estimating training effectiveness. This problem is similar to estimating Pr(kill) and Pr(hit) for weapon systems. It is very difficult problem and a workable approach will provide substantial benefit to both unit trainers, readiness planners and acquisition officers.

Development of a Performance Assessment Package for DIVARTY Staff Training

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A critical component of any training environment is the ability to accurately diagnose performance deficiencies for feedback and follow-on training. To accomplish this reliable and valid performance measurement protocols must be developed, ideally, within the context of a systematic approach to training development. The most accurate and useful performance diagnosis is based on an assessment package that is sensitive to the detailed processes that occur during training. An instructional approach to training that makes the collection of detailed process measures efficient is known at the Event Based Approach to Training (EBAT). This effort used the EBAT framework to guide the development of a comprehensive performance assessment package for supporting the assessment of DIVARTY staff training.

The scope of this performance assessment project covered the training activities of five cells of the DIVARTY staff in tactical environments. The activities were distributed across the DIVARTY cells and integrated through a training scenario with a time ordered events list. The assessment of training performance included activities that occurred both within and between the DIVARTY cells. The training events were inserted into the scenario to stimulate staff performance. Tactically acceptable responses were identified in advance and staff performance was measured against these standards. The measurement instrument referred to as TRACE (Tactically Relevant Assessment of Combat Events) is a highly detailed method for evaluating staff performance in tactical environments. This presentation will cover the development, tryout, and analysis of team performance data related to the TRACE instrument.

ASW Proficiency Measures

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The presentation updates the working group on progress and achievements since last year and demonstrates the working application developed for CINCPACFLT. The Anti-Submarine Warfare (ASW) Proficiency Project (ASWPRO) developed an innovative methodology for predictive unit readiness based upon mission processes resources and outcomes as they relate to measured unit mission performance.

The presentation discusses validation and testing of the model, as well as current efforts to adapt the ASWPRO model to the aviation, submarine and surveillance communities. Implications for training and readiness, reporting and further research are discussed. The application was programmed using Access 97 and Visual Basic for use in the "IT-21" workstations and was tested in-situ on the local area networks of COMNAVSURFPAC and CINCPACFLT.

Considering Organizational Learning at Military Microworlds

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Discussion and insight into organizational learning and microworlds and learning laboratories continues to develop in the research literature. Simuworlds and microworlds have served and continue to serve as practice fields for organizational learning. The benefits of having a learning organization include at the very minimum increased organizational competitiveness and responsiveness to its mission. Organizational learning mechanisms like the simuworld practice fields have been linked to organizational learning through a taxonomy for rare events. Yet parallels between these insights and the collective and joint training at the US Army National Training Center and the Joint Readiness Training Center have rarely been made. This research considers the readiness training occurring at these centers in light of the vernacular and perspective of organizational learning research efforts. Specifically this research considers the level of organizational learning occurring at the centers and explores possible correlation with approaches to learning taken during after-action review sessions. This research indicates that organizational culture, leadership emphasis and interpersonal communications may be related to the potential for adaptive or generative organizational learning through these paradigms.

<u>*Thursday, 1030-1200 MODELING COLLECTIVE TRAINING*</u>

The Utility of Modeling and Simulation in Fleet Training

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The presentation addresses the methodologies and results of the first step in a three-step process to assess the utility of modeling and simulation in fleet training. The assessment focused on the potential to substitute modeling and simulation for underway/in-flight training and thereby reduce operating costs associated with the training process. Assumptions used to form reasonable parameters that allowed the establishment of training costs at sea for surface and aviation forces will be covered. Once costs were reasonably established it was possible to determine cost avoidance estimates through the substitution of modeling and simulation. The presentation will address the implications for the findings including readiness in the forces, fidelity of modeling and simulation, availability of modeling and simulation, expectations of the operators and the next steps in the assessment process.

Development of a HLA, PC-based High-resolution, Constructive Combat Simulation

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Today's no-notice contingencies require rapid military response. High resolution, constructive combat simulations offer Army leaders at brigade through platoon with an effective tool for rehearsing military operations ahead of time. However, existing simulations typically reside on large, unwieldy simulation platforms. Scenario generation is time-consuming and tedious. Together, these factors make it difficult for commanders to use combat simulations for training and mission rehearsal when preparing for military operations.

Significantly increased computing power of personal computers (PCs), combined with their low cost, user-friendly graphical interfaces, and wide familiarity, makes them a very attractive and logical candidate as a simulation platform for supporting training and mission rehearsal. Furthermore, PC-based simulations will present military leaders with additional opportunities to prepare for training events and field exercises by providing soldiers at all levels a user friendly tool to rehearse tactics, techniques and procedures.

This paper discusses research and development of a high-level architecture (HLA) compliant, PC-based, high-resolution, multi-sided, constructive combat simulation. This will be accomplished in two phases. Janus Fortran simulation source code will be converted to C++. The system will be reconfigured from a Hewlett Packard (HP) platform to a PC platform using a Windows NT. Notable development concerns include scenario runtime, system validity and verification, system calculations, and screen refreshing time. The project will also make the PC simulation HLA compliant as mandated by the United States Department of Defense. The HLA effort will build upon previous work to make combat simulations operable in a Distributed Interactive Simulation (DIS) environment. The project will test the prototyped HLA PC simulation by linking two HLA PC models in a federation and running test scenarios.

Linkage of Constructive Analytical Models to C4I Systems

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Appliqué is a digital command and control system used at brigade and below consisting of PC class computers and software using modern Graphical User Interfaces. Appliqué systems link individual operational elements, throughout a brigade structure using the Tactical Internet communications architecture in conjunction with the other systems of the Army's Tactical Command and Control systems (ATCCS). Appliqué and ATCCS were used by 1 brigade Combat Team, 4th Infantry Division for the TF XXI AWE at the NTC.

There was a requirement to do both effective analysis of the emerging C2 systems as well as train the unit to use the systems within the bounds of limited time and money. Janus, the Army's primary analysis and training model for Bde and below was enhanced in order to link to Appliqué systems. Training was conducted used Janus at the Bde, Bn, and Co/Tm level prior to the NTC AWE, Post-NTC analysis was done in a BCT Janus appliqué exercise. The training and analysis efforts are described as well as the architecture to support simulation driven CPX exercises.

The next step in the evolution of the tactical digital C2 system will be the next version for Appliqué which will be named Simulation Testing Operations Rehearsal Model (STORM). FBCB2 will go through a limited user test (LUT) in FY 98 and an FDTE and IOTE in FY 98-99. The requirement for training and testing with constrained time and money will be similar to TF XXI. There fore an initiative to continue the development of a simulation capable of addressing both the unit's training requirement and analytical and text requirements is being planned. The project is called STORM and TEXCOM is the proponent for STORM. The initial design phase for Janus use in STORM will be described.

Simulation Support for Land Warrior

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The mission to close with and destroy the enemy by fire and maneuver has and will continue to fall on the infantryman. Although his mission remains unchanged, the integration of optic, battlefield awareness and digital communications system available to the 21st century Land Warrior can dynamically enhance his lethality. The initiative to combine these technologies with synergistic effects is called Land Warrior XXI. It represent a $1.4 billion investment by the Army to ensure that the US infantryman maintains a decisive edge over potential enemies.

However, as with any federation of combat systems, the ability to maximize its potential is linked to the mastery of individual and collective tasks. This requisite expertise will be gained through the combination of virtual and live simulation training exercises conducted throughout the world.

This presentation will address infantry simulation requirements to train individual and collective tasks with Land Warrior XXI systems and explore some of the difficulties associated with meeting these needs.

Thursday, 1330-1500 - COLLECTIVE TRAINING SUPPORT

A Framework for Assessing Value Added of New Training Technologies

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Information age systems have high performance potential, but the training necessary to realize this potential is often difficult or impossible to conduct using conventional training methods. Furthermore, many new high-technology training methods are still in their infancy and it remains to be unambiguously demonstrated whether they can deliver on their up-front promises. The issue of incremental benefit is often referred to as the value added problem. In the proposed presentation we will provide a definition of value added, contrast value added with cost effectiveness, and describe a methodology for assessing value added that addresses the following hierarchy of questions. (a) is the potential training application <u>suitable</u> for the technology in question? (b) is the training application <u>effective</u> in improving performance of the required

skill repertoire in the target population? (c) is the potential application superior to conventional training methods? (d) is the demonstrated training superiority operationally relevant to mission success? The case for a potential training application having value added is strengthened as the question defining each level of the hierarchy is answered in the affirmative. We will describe approaches designed to answer each question, running the gamut from a thorough front-end analysis, through a series of well-designed simulated or actual training exercises, to multiple runs through combat simulation models, and where the empirical training effectiveness measures are often derived from *quasi experiments.* This value added framework will be discussed in the context of a new multi-service distributed interactive training simulation testbed.

Expected Effects of Force Modernization on Exercise Control and Feedback in Live Simulation Exercises

Expected Effects of Force Modernization on Exercise Control and Feedback in Live Simulation Exercises

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At the request of the US Army Training and Command Combat Training Support Directorate, we examined the impacts of force modernization (new weapons, new sensor systems, and digitization of the battle space) on the work trainers and analyst must do to support fore-on-force exercises in live simulations. This work was needed to provide input for developing requirements for future training instrumentation. We used the Army Science and Technology master Plan and Internet Web Sites to identify system expected to be fielded over the next ten years and gain an understanding of the intended capabilities, operation and employment of over 140 of these systems. We described tasks currently performed by observer/controllers (OC) and analysts to support the simulation of system effects (intrinsic feedback) and pro9vide post-exercise (extrinsic) feedback for units at the Army's maneuver combat training centers. Based upon the capabilities of current tactical engagement simulation (TES) and instrumentation systems, we estimated whether specific elements of feedback would be provided by a TES/instrumentation system, an OC analyst, or through soldier interaction with an operational system. We also identified cases where feedback voids were expected. In the absence of interventions ,d force modernization will substantially increase the work required to support the simulation of systems and provide formal post-exercise feedback In addition, the digitization capabilities that give the units information dominance over the enemy have the side effect of making it more difficult for trainer to monitor exercises and track the flow of information within units. current efforts include designing information displays to support exercise control and feedback functions on the digitized battlefield.

A Methodology for Assessing Knowledge Organization in Teams: Implications for Training Design

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In many military environments teams are required to coordinate their tasking for the effective execution of a mission. Time constraints and operational stressors frequently limit the ability of these teams to retrieve information, communicate, or develop a shared representation of the tactical situation. To mitigate the effects of these and other critical factors, teams need to develop strategies that allow for the common organization of knowledge. Scenario based training is one method by which team members can develop similar organization of concepts through shared experience. Shared organization of knowledge enables teams to better predict each others behavior, adapt to a changing environment in an integrative manner, and coordinate with one another. While training teams together may facilitate the development of a common knowledge organization, this knowledge is frequently tacit and therefore difficult to assess. This limitation has the potential to reduce the effectiveness of training. Based on the results from a case study, a methodology to assess knowledge organization in teams is proposed. This methodology provides a formal process for selecting concepts which are then submitted to the Pathfinder Knowledge elicitation-representation process. Knowledge representations are examined to evaluate team member expertise and similarity of team member's knowledge organization.

This paper will: (1) identify the challenges for developing and conducting the assessment of knowledge organization in operational training settings, (2) present results from recent applications of the methodology, (3) identify training implications of this methodology, and (4) describe future research and application of methodology to other areas.

WG 23—BATTLEFIELD PERFORMANCE, CASUALTY SUSTAINMENT, AND MEDICAL PLANNING

Chair: Mr. Christopher G. Blood, Naval Health Research Center
Cochair: Major Robert L. Syvertson HQ DA, DASG-HCO
Cochair: Mr. William Pugh, Naval Health Research Center
Advisor: Dr. W. Peter Cherry, Vector Research Inc.
Room: I-381

Tuesday 1030 – 1200
Examination of Methods to Input Leadership or other Soft Factors into Models and Simulations
Mr. Gerald A. Halbert, National Ground Intelligence Center, (804) 980-7560

Analysis of Performance During ASW Battle Training
Dr. B. Charles Tatum, Navy Personnel Research and Development Center, (619) 553-7955

Improved Mathematical Model for Calculating Glint Visual Threshold Domains
William J. Chevalier, Soldier System Command, Natick Research & Development Center; (508) 233-5359

Tuesday 1330 - 1500
Attrition Curves for Combat Models Using Force Ratio
LCDR Aasgeir Gangsaas, Joint Staff, J-8, Warfighting Analysis Division, (703) 695-3156, Unclassified FAX (703) 693-4601

The Rate Planners Guide to Battle Casualty Rate Patterns for Conventional Ground Forces
George Kuhn, Logistics Management Institute, (703) 917-9800

Wednesday 0830 - 1000
Risk of Extreme Events: Terrorism, Weapons of Mass Destruction, and Casualty Prediction
Maj Robert Syvertson, HQ DASG-HCO, (703) 681-8194

Using Discrete Event Simulation to Model Medical Evacuation
LtCol Patrick McMurry, U.S. Army Medical Department Center and School, (210)221-0938

Medical Supply Modeling
Bruce Shahbaz, Vector Research (210) 832-3000

Wednesday 1030 – 1200
Validation of Wartime Medical Requirements
COL Sarah Wright, USAF/WAR-MED Planning Systems Office, (301) 619-7506

The Independent Verification and Validation of the Medical Analysis Tool
Ms. Jamie Pugh, Naval Command, Control and Ocean Surveillance Center, (619) 553-1632

Analysis of Inter-Echelon Patient Flow
Mr. G. Jay Walker, GEO Centers, Inc, (619) 553-8393

Wednesday 1330 – 1500
COMPOSITE GROUP E SESSION .... Room I-122

Thursday 0830 - 1000
Reducing the Logistical Footprint of Forward Medical Units Using a Patient-Driven Model of Clinical Events
Mr. Michael Galarneau/ Dr. Paula Konoske, Naval Health Research Center, (619) 553-8411

VR Mission Rehearsal Tools for Modeling & Simulation of CBW Medical Missions: Training as We Deploy
COL Annette Sobel, Sandia National Laboratories, (505) 844-1411

Mobile Warfighting and Event-Oriented Casualty Estimation
David L. Danner, Ph.D., P.E., Ideamatics, Inc., (703) 903-8949

Thursday 1030 - 1200
Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats
Mr. Walter Estrada/Dr. Tom McIlvain, TASC, (781) 942-2000

Toward a Unified Medical Staffing Model: Restoring Order to a Military System
MAJ Mark J. Perry, Ph.D., Army Medical Department Center & School; (210) 221-6493

WG 23—BATTLEFIELD PERFORMANCE, CASUALTY SUSTAINMENT, AND MEDICAL PLANNING
Room: I-381

Tuesday, 1030 - 1200
Examination of Methods to Input Leadership or Other "Soft Factors' into Models and Simulations

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Abstract: In analyses of past conflicts, troop or strategic leadership has consistently been mentioned by historians as affecting the outcome of battles, campaigns, and wars. The majority of models and simulations used to examine battles and campaigns are well developed and fairly accurately portray the effects of weapons and the maneuver of units on the outcome of engagements. However, these models and simulations do not normally include consistent methods of evaluating the effects of leadership at various levels, and the effect of good (or bad) leadership on battle outcome. In the 21st Century, we must be able to model the impact of soft factors. Recently, several groups of analysts have been studying methods to assess the importance of leadership in battle and to develop ways in having these appraisals numerically evaluated so they may be used as inputs in the models and simulations. The TASC Corporation has developed the PERSPOT model to evaluate several soft factors and integrate the effects to allow input of soft factors to the TASFORM model. Analysts at the National Ground Intelligence Center (NGIC) have developed a method to use their leadership evaluation methodology to provide input to PERSPOT and similar sub-models for other models and simulations. While additional research needs to be done to quantify the effects of leadership and other soft factors such as degree and level of training, or morale and cohesion, there is a need to explore this area by the modeling and simulation community. This presentation discusses a specific approach being explored to improve models and simulations by including information about leadership.

Analysis of Performance During ASW Battle Training

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Recent reports on the status of military readiness have concluded that battle capability is difficult to measure and hard to predict (Congressional Budget Office [CBO], 1994; Defense Science Board [DSB], 1994; General Accounting Office [GAO], 1994a, 1994b; Moore, Stockfisch, Goldberg, Holroyd & Hildebrandt, 1991; Tatum, Laabs, & Nebeker, 1998). The purpose of this presentation is to assess battle readiness using training proficiency measures, and identify factors that predict these readiness levels. A multiple regression analysis was performed on exercise scores obtained during ASW battle exercises on 16 Naval ships (five cruisers, six destroyers, and five frigates). The results demonstrate that battle performance was predicted (R2 = .72) from four sets of variables: (a) mental quality of personnel, (b) skill level of personnel, (c) personnel assignment, and (d) ship training level. Of the four factors, skill level and personnel assignment were the strongest predictors of performance. The implications of these findings are that (a) readiness assessment should be based on battle performance of units, and (b) efforts to improve skill level and proper personnel assignments will have the biggest impact on military readiness and sustainability. The presentation will also discuss the kinds of data required for future work on this problem.

Improved Mathematical Model for Calculating Glint Visual Threshold Domains

William J. Chevalier, Mathematical & Statistical Analysis Team,
Science & Technology Directorate
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Soldier System Command, Natick Ma., 01760-5015,
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This paper describes the development of an improved mathematical model for calculating glint visual threshold domains. This model can serve as a design tool in the application of low reflective technologies to specular reflecting surfaces on dismounted soldier individual equipment, particularly eye wear. This is achievable by mathematically describing the attenuation of solar glint energy (0.4 - 0.7μm) over the

sun to ground reflecting surface (eye armor) to observer optical path. The solar energy attenuation begins with the effects of the solar zenith angle coefficients on the zenith solar intensity value since length of sky to ground optical path segment changes with solar elevation angle. Specular energy will further attenuate at the ground reflecting surface based on surface reflectivity properties and incidence angle. In fact, the design tool applications of this model are fundamentally based on changes in surface reflectivity properties which will correspond to changes in the visual threshold domains calculated by this model. The attenuation of reflected solar specular energy transmitted from ground reflecting surface to observer is described by atmospheric extinction through absorption and scattering and by turbulence, based on Bouguer's and Beer's laws. The influencing factors include air temperature, humidity, aerosol and particle mix. Calculations of glint threshold visual domains will be based on the application of spectrally resolved and integrated contrast ratio concepts. The advantages in using this approach is that the contrast ratio is independent of solar intensity. The object reflecting surface is considered as a point source while the background as an extended object. Detector angular spread and resolution play a role in the visual domain calculations since the model is detector (eye) dependent.

Tuesday 1330 - 1500

Attrition Curves for Combat Models Using Force Ratio

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A common problem with legacy campaign models is the lack of pedigree in critical data supporting the model. Without proper documentation, the study, used for decision making, can result in both embarrassing questions and, in the worst case scenario, the wrong course of action. In preparation for a major study using our theater level campaign analysis model, a thorough review of input data was conducted. One critical area was the review of the attrition curves used to determine equipment and personnel casualties as a function of force ratio and posture. No one in our organization could explain these relationships, nor was there any documentation regarding their origin. Using historical data, numerical analysis, and graphical techniques, new attrition curves were developed, tested, and certified for use. Additionally, the steps used to gather, analyze the data, and test the derived attrition curves were documented so that someone else could reproduce the results. This paper provides both the steps in the development of attrition curves for theater level campaign models; and perhaps more importantly, a case study that others might use to address similar problems.

Ground Forces Battle Casualty Rate Patterns and Estimates

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The behavior of conventional battle casualty rates for conventional ground operations is described for planning purposes in terms of rate patterns keyed to three general parameters: forces, time, and operational *form*. The "rate patterns" approach — supported by the Joint Staff, authorized for use and now being fielded by the Army — brings planners three previously unachieved capabilities: to define *reasonable* [empirically indicated] levels and durations of average total battle casualty rates across multidivision-size forces (e.g., for deliberate planning in the two MTWs); to determine how those totals are apportioned into wounded versus killed/captured/missing (proportions that tend to shift dramatically among the different operational *forms*, a fact previously absent in planning); and to measure how high possible "hot spots" could be (for single divisions on single days, again previously invisible to planners) given an overall average. Planners can construct their own rate profiles, and/or evaluate the reasonableness of profiles from other tools (including simulations, which have been known to produce unrealistic personnel casualty rates). The new approach will be outlined in the context of planner needs as well as some other recent research results.

Wednesday 0830 – 1000

Risk of Extreme Events: Terrorism, Weapons of Mass Destruction, and Casualty Prediction

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One of the most urgent challenges facing the national security of the United States is the proliferation of weapons of mass destruction and their potential use against United States interests. The materials and expertise to build chemical and biological weapons are readily available to the governments and organizations that support or conduct terrorist activities. Nuclear material and the expertise required to build nuclear weapons are more accessible today than ever in history. As potential for use has grown, increasing emphasis is being placed on the ability of the United States to react to the use of a nuclear, biological or chemical weapon. One measure that will be used to gauge the success of the response will be the ability to deal with resulting casualties. Paramount to this success will be the ability to estimate and plan for the care of these casualties. This paper examines the risk assessment process as it applies to the use of nuclear, biological, or chemical weapons by a terrorist organization. Using data from conventional terrorist attacks, this paper develops the use of the statistics of extremes in an effort to estimate potential casualties. The partitioned multiobjective risk method (PMRM) and the conditional expected value both provide measures

of the risk of such extreme events. This information can be invaluable to the planners developing responses to the use of these types of weapons by terrorist organizations. As the potential for use of these weapons increases, so must the ability of planners and policy makers to conduct effective risk assessment and management to minimize their effects.

Using Discrete Event Simulation to Model Medical Evacuation

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The Medical Evacuation Model is a discrete event simulation of casualty movement through the levels of medical care in a theater of operations. The model's primary purpose is to provide insight and analysis capability on resource requirements and allocation methods for ground and air evacuation platforms to support a given patient workload. The model allows the use of dedicated ambulances (air and ground) and/or platform lifts of opportunity (i.e., C-130, V-22, etc.). Casualty processing locations include casualty collection points, aid stations, ambulance exchange points, medical treatment companies, a combat support hospital, a casualty receiving ship, a hospital ship, a tactical airfield, a strategic airfield, and a mobile aeromedical staging facility. Input variables include:

- quantity of each type of evacuation platform
- quantity and schedule of evacuation platform crews
- number of casualties for each arrival period
- enroute times between casualty pickup and drop-off points
- arrival cycles of platform lifts of opportunity

Statistical summaries are available for resource utilization, casualty data, and workload. The model has options to specify and capture additional output for use as input to other models or analysis. The model was built using MedModel software (version 3.5) and includes animated displays of the simulation.

Class VIII Resupply Analysis

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As a result of the Combined Arms Support Command's (CASCOM's) "Revolution in Logistics" the method of supply distribution on the Army's Force XXI battlefield has been significantly changed from the current stockage based system to a transportation based system. These changes have resulted in "through-putting" supplies from the Corps down to the brigade and battalion level, bypassing the division support area where the Class VIII inventory for the division had been kept. The goal of Battlefield Distribution is to reduce the logistics footprint forward while maintaining responsive, timely, and effective logistical support.

Key AMEDD leaders need to determine what changes in transportation requirements and doctrine are required under the Force XXI redesign. A simulation model was developed to examine how alternative combinations of variables, including requisition flow, processing times, casualty rates, and order-ship time affect patient care. The goal of this analysis was to assist decision makers in determining how to best conduct Battlefield Distribution of Class VIII Supplies. The analysis found that anticipatory logistics is a significant improvement over the current demand based system for supporting sustained combat operations. For low casualty rates, the majority of supplies can be shipped by ground assets; as these casualty rates increase, more reliance is placed on air transportation. Anticipatory logistics reduces this reliance on air transportation, as well as mitigates much of the risk of not having critical supplies available when they are needed. The most difficult challenge for the medical logistics system is to support sudden surges in workload in individual units that are geographically dispersed.

Wednesday 1030 – 1200

Validation of Wartime Medical Requirements

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The purpose of this presentation is to provide an overview of the application of clinically focused protocols as a method to evaluate the match of patient requirements to deployed medical capabilities and resources. The AFMS UTC Validation Model will be discussed as one tool available to examine the impact of medical reengineering on clinical care. Potential applications of the same clinical protocol database to all DoD medical modeling and simulated battlefield training will be explored.

The Independent Verification and Validation of the Medical Analysis Tool (MAT)

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The Global Command Control System (GCCS) and Global Combat Support System (GCSS) recently replaced the Worldwide Military Command and Control System (WWMCCS). The Joint Operational Planning and Execution System (JOPES) was tied to WWMCCS and the Medical Planners Module (MPM) was linked to JOPES. As a consequence of this change, the Medical Planners Module (MPM) in no longer available for use by the medical planners and a decision has been made to replace MPM with the Medical Analysis Tool (MAT) Requirements Generator (RG) in the new system. A second tool available for use was the Logistics Processor External - Medical Module (LPXMED). LPXMED, although it remains in use, was never fully tested and does not contain a requirements generator. The Medical Planning and Execution System (MEPES) was programmed to incorporate MPM and LPXMED functionally and replace them. MEPES was never completed and the medical community was left without an approved tool for medical planning and programming. The Medical Analysis Tool (MAT) is both a Requirements Generator (RG) and a Course Of Action Analysis (COAA) tool. It therefore contains both the MPM and LPXMED functionality. Space and Naval Warfare Systems Center San Diego D714 was tasked by the Theater Medical Information Program (TMIP) Program Management Office (PMO) to perform an Independent Verification and Validation (IV&V) of the Medical Analysis Tool Version 1.0 (MAT V1.0). MAT V1.0 will be the first official release of the software. This talk discusses the IV&V currently underway on MAT V1.0. The approach used mixes formal and informal IV&V procedures, and adds a "user" IV&V test to these.

Projecting Inter-Echelon Patient Flow for Military Operations

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Hospitalization data were extracted for Marines hospitalized in Vietnam from 1965 to 1969 to examine the echelon flow of treatment care for different type of injuries and illnesses. The interechelon movement of each patient who was seen at an Echelon II or III facility was tracked until the treatment was completed or until the patient was moved to a continental U.S. (CONUS) facility. Results showed that over half of the wounded-in-action (WIA) admissions to Echelon II or III had no further treatment recorded at a higher echelon of care. Approximately one-fifth of the patients required treatment at an Echelon IV facility, while almost one-third were seen at an Echelon V facility. In contrast, analyses indicated that less than 17% of disease/nonbattle injury (DNBI) admissions required treatment at an Echelon IV or V facility. For both WIA and DNBI data, inter-echelon flows showed variability by diagnostic category.

Wednesday 1330 – 1500
COMPOSITE GROUP E SESSION .... Room I-122

Thursday 0830 - 1000
Reducing the Logistical Footprint of Forward Medical Units Using a Patient-Driven Model of Clinical Events

Mr. Michael Galarneau/Paula J. Konoske, Ph.D., Gerry Pang, Kristee Emens-Hesslink, HMC Douglas Lowe, & LCDR. Gregory Bowling
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The mix of medical supplies and equipment that are deployed to treat Marine combat casualties at far forward areas of care are specified in Authorized Medical Allowance Lists (AMAL) and Authorized Dental Allowance Lists (ADAL). It is critical that AMALs/ADALs are configured so that sufficient quantities and combinations of medical supplies are available to sustain an operation. Recent changes in Marine Corps doctrine and policy, as well as reduction in expected casualties, warrant a reexamination and revision of existing AMAL/ADAL configurations. The goal of the present effort was to review the AMAL/ADAL compositions to ensure that they reflect these changes. First, algorithms were developed that tie specific medical resources to the clinical requirements associated with treatment of individual medical conditions at forward areas of care. These algorithms were then incorporated into a model which estimates the needed supplies and equipment based upon the overall expected casualty incidence, as well as the composition of the patient stream. When the proposed AMALs were compared to the current AMAL configurations, substantial reductions in the number of items, weight and cube were realized for the laboratory, x-ray, Battalion Aid Station (BAS), and Operating Room equipment and consumable AMALs. For example, 25 % of the items in the BAS equipment AMAL could be eliminated with a corresponding 33 % reduction in weight and 55 % reduction in space, while in the proposed BAS consumable AMAL there was a 23 % weight savings and a net space savings of 30 %. By establishing the clinical requirement for each item pushed forward, the model was able to reduce the logistical burden carried by Marine Corps units. This approach provides medical planners and logisticians with a management tool for maintaining and updating supplies and equipment by developing a supply stream that establishes a clinical requirement for each item used to support forward medical care. The Marine Corps Combat Development Center has endorsed this review process and has recommended that the process be used for the evaluation of the remaining AMALs. Additional efforts are underway to use this methodology to evaluate the AMAL/ADALs of shipboard medical departments.

VR Mission Rehearsal Tools for Modeling and Simulation of CBW Medical Missions: Training as We Deploy

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This presentation will focus on the medical algorithm-based VR-DIS, fully-immersive mission rehearsal and training environment developed at Sandia National Laboratories. Collaborators at the Henry Jackson Foundation/Tekamah Corporation developed the underlying baseline treatment algorithms which were subsequently modified for this application. This environment uniquely employs contingency-oriented, multiple-path algorithms, MOEs/MOPs focused on real-world operations, and small team situational training based on realistic medical mission stressors. The selected prototype scenarios are representative of combined injuries anticipated with high probability in CBW operations. Mission-related stressors are subsequently overlaid on the selected injury scenarios. Scenario and algorithm validation techniques and human factors engineering based performance metrics will be discussed within the scope of mission rehearsal requirements.

Mobile Warfighting and Event-Oriented Casualty Estimation

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The purpose of this paper is to address the estimation of casualties and future concepts of operation for the U.S. Marine Corps based on maneuver warfare and over-the-horizon projection of forces. The use of smaller fighting units with limited periods in combat zones and minimal supporting forces at risk invalidates the paradigm of casualty projections using a population at risk for a duration of time at a fixed rate. The new paradigm is event-oriented; relying on the application of a rate based on the activity being conducted. Founded in the work done on the USMC Casualty Estimation Model (CASEST), the incidence of casualties are estimated on a basis of unit actions. Significant engagements are identified and casualties are estimated for each. As shown previously and presented at the 65th MORSS, examination of casualty data shows that the incidence of aviation casualties is dependent upon the number of sorties flown and the intensity of anti-aircraft defense encountered during the sorties. A similar analysis can be performed for conventional ground warfare. Since the types of events can be expanded upon ad-infinitum, the author has limited the investigation to small unit ground tactical operations. A complete description of the methodology is presented along with preliminary data and results.

<u>*Thursday 1030 – 1200*</u>

Developing a Model of Commercial Readiness: Conventional and Non-Conventional Battlefield Threats

Walter Estrada, Project Manager
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As DoD budgets decline, depots are closed, and forces are reduced, the warfighter's reliance on large DoD inventories must be replaced by greater dependency on direct commercial supply sources. In this new environment, full war/contingency materiel support readiness assessment can no longer be considered complete or realistic unless it includes an assessment of commercial sources. In addition, future scenarios are more likely to involve non-conventional threats, such as nuclear, biological, and chemical (NBC) weapons. Also referred to as Weapons of Mass of Destruction (WMD), their name suggests a potential reality, that these weapons can produce large numbers of casualties in a single attack. The numbers of casualties produced may significantly strain the medical logistics system over and above conventional plans. This will raise new, perhaps even unique issues of medical resource forecasting.

To address these challenges, the TASC team is developing a fully threaded rapid supply support readiness assessment and planning capability. This includes the ability to forecast with greater accuracy the future materiel states of the commercial base and its correlated ability to support warfighter needs ("commercial readiness"). To address NBC, we plan to integrate a nuclear, biological, and chemical (NBC) medical logistics planning model, called NBC MedPlans , into our current commercial readiness model demonstration.

Toward a Unified Medical Staffing Model: Restoring Order to a Military System

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Staffing patterns for military medical treatment facilities have evolved over time in a chaotic manner, following the path of least resistance to satisfy the multiple and sometimes conflicting objectives of line and medical unit commanders, military health care beneficiaries, and real or imagined budget constraints imposed by MACOMs, Department of the Army, and the Department of Defense. The advent of managed care paradigms have resulted in major staffing changes in private sector health care organizations, with the potential for large savings. Some of these savings result from a transition to less expensive labor - utilizing more primary care physicians and physician extenders such as physician assistants and nurse practitioners, rather than staffing patterns dominated by specialists and subspecialists, while other savings result from reengineering the process and structure of the care-giving environment, including demand management, utilization review and management, quality improvement, and risk sharing. A variety of mathematical models have been used to aid in human resource allocation decisions, concentrating on various components of the system, without concern for the costs and benefits to the total organization. This paper explores the potential for development of a unified model for optimizing staffing patterns across the Army Medical Department.

WG 24 - MEASURES OF EFFECTIVENESS - Agenda

Chair: Robert J. Meyer, NAWC-WPNS
Cochair: Lt Col Mark Reid, AFOTEC
Advisor: John M. Green, Lockheed Martin
Room: I-323

Tuesday, 1030-1200
Revolutions in Military Affairs, New Measures of Effectiveness, and Good Old Fundamental Objectives
Lt Col Dan Maxwell, OSD/PA&E, JWARS Office

Analysis of Alternatives Using Optimal Weapon Allocation to Minimize Mission Costs
James LaMar, Engineering Specialist, Northrop Grumman Corporation

Linking Effectiveness Measures and Simulation Validation Criteria - Techniques for Defining "Good Enough"
Dr. Frank B. Gray and Major Suzanne M. Beers, Hq AFOTEC

Tuesday, 1330-1500
Submarine-vs-Submarine Duels: Balancing Kill and Counter-Kill
Dr Jerome C. Rosenberger, Institute for Defense Analysis

Quantitative Analysis on the Utility of Antipersonnel Landmines (APL)
Colonel Wm Forrest Crain, U.S. Army Concepts Analysis Agency

Planning Tool for Operational Fires (PTOF)
Capt William M. McLagan, U.S. Army Concepts Analysis Agency

Wednesday, 0830-1000
Metrics for Warfighting Experiments
Al Sciarretta, Quantum Research International, and Jim Pittman, The MITRE Corporation

C4I Analysis Across a DIS Network
Capt Dave Smith, Det 4, 505 CCEG (TACCSF) and George T. Cherolis, TACCSF Tech Support Contractor

Wednesday, 1030-1200
Command, Control, Communications, Computer, and Intelligence (C4I) Systems Test and Evaluation
Albert J. Starnes and Douglas J. McGowen, C4I Systems, Hq AFOTEC

A Methodology For Establishing, Assessing, And Quantifying Family Of Systems Interoperability Requirements For Alternative Theater Air Missile Defense BMC4I SR Architectures
Dennis Mensh, Senior Engineer, PRC Corporation

A Test Paradigm for Wargame 2000 (WG2K)
Dr Michael Lyons, Joint National Test Facility (JNTF/MITRE)

Wednesday, 1330-1500
MTI Sensing: Quantifying Coverage Capability
Kurt Willstatter, MRJ Technology Solutions, Inc.
Kenneth Cogan and George Teas, Adroit Systems, Inc.

JTCG/ME Automated Products for Planning
Dr Erwin Atzinger, JTCG/ME, U.S. AMSAA

Thursday, 0830-1000
COMPOSITE GROUP E SESSION .... Room I-122

Thursday, 1030-1200
The Necessity for Integrating Space Assets into Campaign Analysis
Capt James R. Hunter and Capt Mark A. Powers, Air Force SMC

Linking MOEs to a Composite Measure of Success: A Case Study from the SAIP Assessment
Dr John M. Irvine and Gregory S. Lamond, SAIC, Inc.

Modeling and Simulation for DD 21
Dr John Bailey, Operations Research Analyst, NSWC, Dahlgren Division

Thursday, 1330-1500
Development of a Combat Potential Metric for Air Combat Command
Dave Hickman, Air Combat Command

Mine's Bigger Than Yours: Taking the Measure of MOEs and MOPs
Robert J. Meyer, Operations Research Analyst, NAWC-WPNS
(for Noel Sproles, Australian Centre for T&E)

Negating the Threat: Replacing Attrition Reduction MOEs in the Post Cold War Era
Robert J. Meyer, Operations Research Analyst, NAWC-WPNS

WG 24 - MEASURES OF EFFECTIVENESS - Abstracts
Room: I-323

Tuesday, 1030-1200
Revolutions in Military Affairs, New Measures of Effectiveness, and Good Old Fundamental Objectives

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Joint Vision 2010 prescribes a doctrine that capitalizes on emerging military and information technologies. The systems and doctrine are proven. Simulations and experiments have provided the requisite evidence; the long-awaited revolution in military affairs (RMA) has arrived.

The military operations research community has been a key part of the RMA. We have been the purveyors of quantitative evidence of the increasing efficiency of America's military. Given the RMA, we now seek new measures of effectiveness (MOEs) that will help us to better demonstrate potential contributions of the new systems and doctrine. The hypothesis is accepted; the RMA is a robust replacement to existing capabilities and doctrine.

This paper postulates the existence of an enduring set of fundamental objectives that military analysts can apply as a foundation for their analysis in the future. These objectives are reflective of the essential reasons that national leaders are interested in military effectiveness. A chain of reasoning is then offered that connects these fundamental objectives to the tasks that are performed by military forces. The reasoning also connects the objectives to the doctrine and systems that are being developed to accomplish these tasks. The presentation concludes with some thoughts on how the military analysis community could apply this paradigm to better support defense leaders.

Analysis of Alternatives Using Optimal Weapon Allocation to Minimize Mission Costs

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In the development of affordable strike aircraft, mission and cost effectiveness are major drivers in the generation of requirements. This presentation describes a linear programming methodology which provides the cost and operational effectiveness of alternative weapon systems concepts, and the degree to which the alternatives are capable of meeting the system's mission objectives. This methodology minimizes the total mission cost by optimally allocating weapons based on weapon cost, attrition cost, and sortie operational costs. Weapon resources are filtered by mission constraints, delivery system parameters, and weapon resource parameters. Cost and performance results provide the measures of effectiveness to analyze the tradeoffs of the filtering constraints and parameters. An application of this method to a weapon bay sizing trade study is given.

Linking Effectiveness Measures and Simulation Validation Criteria - Techniques for Defining "Good Enough"

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As simulations play increasingly larger roles in weapon system acquisition programs, one might expect a corresponding increase in the need for quantitative, versus qualitative, validation of those simulations. Here we develop objective techniques for relating operational effectiveness measures to observable parameters, so that operational requirements can drive how well the pieces of a composite simulation must perform. These techniques are useful when the performance of individual mathematical models from which a composite simulation is constructed can be compared to the entity that is modeled, but outputs of interest from the simulation cannot. For example, when enemy weapon system performance is simulated we can usually validate that the pieces of a system are modeled properly, but we can't actually shoot at our systems (e.g. airplanes) to see how well the overall simulation works. The techniques presented here use fuzzy set theory and Dempster-Shafer evidential reasoning to link bounds on unobservable operational performance criteria to bounds on observable functional level performance.

Three situations are considered. The first is when there are some limited data available for the actual scenario being simulated. The second is when data on a similar scenario are available. And the third is when no data are available. Examples are given that demonstrate how these techniques provide improvements over TLAR (that looks about right) validation criteria.

<u>Tuesday, 1330-1500</u>

Submarine-vs-Submarine Duels: Balancing Kill and Counter-Kill

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In a force-on-force military confrontation such as a submarine-vs-submarine duel, there is a need to balance one's aggressive actions leading to a probability of kill (P_K) with one's protective actions leading to a probability of counter-kill (P_{CK}). There is often a limit to which one would expose oneself to counter-fire in order to obtain a kill. The submarine-vs-submarine duel provides a good example of this dilemma. Measures that tend to enhance the kill probability often enhance the counter-kill possibilities as well. In a larger sense, considerations of vulnerability versus lethality should enter into discussion of tactics, and lead, through weapon and ship design, to R&D priorities.

Traditional measures of effectiveness (MOEs) that incorporate both objectives, such as 'exchange ratio' and 'weapon system effectiveness' are reviewed. Some new composite MOEs are presented and situations are used to illustrate the utility of the various approaches. A simplified model of the duel leads to a simple, but illustrative formulation as a two-person, zero-sum, matrix game. Solutions by fictitious play are illustrated and the usefulness of this technique is discussed.

Quantitative Analysis on the Utility of Antipersonnel Landmines (APL)

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This effort provides analysis to quantify the military utility of antipersonnel land mine use and assisted the Army in identifying/assessing doctrine and tactics-based force alternatives to mines. This response to the Office of the Secretary of Defense concluded that banning APLs would significantly impact force effectiveness and the ability to achieve military objectives. Results from three separate theater simulations using the Concepts Evaluation Model (CEM) were corroborated with findings from previous tactical level analysis using EAGLE and JANUS.

Measures of Effectiveness used were: whether or not campaign objectives were met; time required to halt the enemy attack; depth of enemy penetration into friendly territory; fractional exchange ratio (FER); major weapon system losses; and personnel casualties. Force alternatives examined included artillery and multiple launch rocket systems (MLRS), attack helicopters, close air support (CAS), and maneuver units. The findings from this analysis influenced Presidential policy on U.S. participation in the proposed global ban of APLs.

Planning Tool for Operational Fires (PTOF)

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Wednesday, 0830-1000

Metrics for Warfighting Experiments

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This presentation will address the growing need for identifying appropriate metrics in support of warfighting experiments (WEs) and attempt to identify specific metrics for C2. WEs are being used more than ever before for evaluating new technologies, systems, tactics, techniques, and procedures (TTPs); with many of these experiments being heavily dependent on modeling and simulation (M&S). Thus, the presentation will focus on C2 metrics for use in M&S-oriented WEs.

Of particular interest is the growing number of WEs focusing on assessing the impact of advanced information technologies on C2 ñ providing information superiority. In developing these metrics, it imperative to consider relevancy, clarity, ìcause and effect,î number of variables, non-quantifiable effects, etc. One must also divide metrics into different levels of importance (e.g., technical performance, tactical effectiveness, and operational utility). Finally to ensure that metrics (and associated measures of performance, measures of effectiveness, and measures of value) are relevant to the Warfighter, a recommended process and taxonomy for description will be presented.

Examples of C2 metrics in support of WEs will be discussed, using the recommended process and taxonomy for description. The presentation will discuss command efficiency, mean acquisition time, cognitive overload, and other C2-specific metrics.
Finally, the presentation will attempt to list similar efforts in the military community that are addressing the development of C2 measures of effectiveness and metrics.

C4I Analysis Across a DIS Network

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Many programs have successfully integrated Joint distributed simulations and real systems using DIS protocols to provide effective simulation of the Joint Warfare environment. Few programs have been able to fully analyze the events that occurred during these exercises or experiments. The Tactical Air Command and Control Simulation Facility (TACCSF) has established a simulation and data collection methodology, architecture, and analytical tool set capable of computing a robust set of C4I MOE/MOP for tests conducted on a DIS network linking virtual, and constructive simulations in a Joint virtual battle space. No new DIS PDUs or additional bandwidth during test execution is required. Each distributed site captures the required data from its simulations or systems during realtime and then does a simple reformat and transmits the data across the T1 to other sites. The data files from distributed sites are then merged in a MS Access relational database to generate a combined Trial Event History for analysis. Examples of key queries used for coordinate and time transformations will be shown. In addition a flow chart of the complex queries which merge truth location and identity information from DIS Entity State PDUs with the appropriate recorded TADIL messages (perceived information) will be discussed.

This presentation will cover the current state of TACCSFís ability to provide accurate and timely data collection on critical operational events to facilitate analysis of performance and effectiveness of Joint operational concepts or C4I systems being tested across a DIS network. Operational performance measures will be addressed from the perspective of an air and missile defense analyst.

Wednesday, 1030-1200

Command, Control, Communications, Computer, and Intelligence (C4I) Systems Test and Evaluation

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A Methodology For Establishing, Assessing, And Quantifying Family Of Systems Interoperability Requirements For Alternative Theater Air Missile Defense BMC4I SR Architectures

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This paper develops basic concepts for the evaluations of Force, Battle Management Command, Control, Communications, Computers, Intelligence, and Surveillance and Reconnaissance (BMC4I SR), Interoperability of Family of Systems (FoS) architecture alternatives. The FoS interoperability requirements are determined from a Joint Forces perspective. The methodology employs Models and Simulations such as the Extended Air Defense Testbed (EADTB), Extended Air Defense Simulation (EADSIM), etc.

The methodology consists of a set of logical steps that are iterative by design. It provides insights and valid estimates of numerical measures of defines force requirements at several levels. This process is not trivial; the expected level of effort could be significant. The method consists of five basic stages necessary to achieve valid results. These stages are: 1) determination of force level requirements, 2) determination of force level capability, 3) analysis of force level capability, 4) determination of FoS BMC4I SR requirements by battle overviews, and 5) determination of force level BMC4I SR requirements - overall.

This methodology can be used by Program Managers for determining top level BMC4I SR requirements for individual FoS in the battle force. In addition, once FoS levels of performance have been defined, the methodology generates a quantitative data base that becomes a useful tool for FoS suite selection. Once alternative combat system suites have been defined, these suites can be analyzed in terms of FoS performance capability versus cost.

A Test Paradigm for Wargame 2000 (WG2K)

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Wargame 2000 (WG2K), under the sponsorship of the Ballistic Missile Defense Organization, is a replacement simulation for the Advanced Real-time Gaming Universal Simulation (ARGUS). The primary purpose of WG2K is to simulate air and missile defense command and control infrastructures, which implies BMC3 and C4I elements needed for air and missile defense, to support the execution of a specified air and missile defense CONOPS. WG2K is being built by the Joint National Test Facility (JNTF) with an initial milestone to conduct a national missile defense wargame by the end of FY98.

In addition to the primary purpose of WG2K, there are future uses planned for the simulation, including a mode of application during developmental or operational tests. For example, WG2K is expected to interoperate with real C4I systems to provide realistic execution and live system test in the places where these operations would normally be conducted, including interoperating with mobile command posts and/or units. Participants will respond according to designated roles and responsibilities, and observations would include human factors with associated measures of effectiveness. A test paradigm for humans-in-the-loop and WG2K includes goals, performance measures and communication parameters. This paper addresses decision aids which should increase the effectiveness of commanders and measures of effectiveness based on time of response and on accuracy of decisions. Additional discussion covers situational awareness and communication parameters in the areas of rate, pattern and content.

Wednesday, 1330-1500

MTI Sensing: Quantifying Coverage Capability

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As a phenomenology, moving target indicator (MTI) for radar is difficult to quantify both from a requirements and a sensor capability perspective. Complicating the issue are varying concepts of operation for the sensors' resultant information as well as modeling target behavior. The mathematical construct presented in this paper was developed to: 1) facilitate explicit modeling of MTI sensors and requirements from an ISR perspective and 2) provide a framework for discussion about relevant measures of effectiveness (MOEs) for MTI coverage.

Key to this approach was decoupling the sensor coverage factor from the actual detections (a function of target behavior). The sensor coverage factor then represents an upper bound on the probability of detection, i.e., the sensor must be available to have an opportunity to detect moving targets. The sensor coverage factor accounts for not only the area coverage per unit time, but also the dwell time required to be effective.

Starting with engineering measures of performance, platform-specific MOEs were developed for each MTI sensor modeled. Obtaining quantifiable MTI requirements has proven much more vexing. Several approaches to implementing MTI requirements have been applied using the modeling construct described in this presentation.

JTCG/ME Automated Products for Planning

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The Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) has developed a variety of CD-ROM products to support the Joint Munitions Effectiveness Manuals (JMEM) Air-to-Surface, Anti-Air, Surface-to-Surface and Vulnerability Working Groups. Our primary goal is to provide nonnuclear munitions effectiveness information for operational commanders, weaponeers, weapon system designers, testers, analysts, trainers, logisticians and DoD targeteers and planners. JTCG/ME publications are Joint Service authenticated field manuals and source documents for the Armed Forces of the U.S. Many volumes have also been provided to NATO and other allies. By performing jointly sponsored military studies and evaluations and marshalling expertise from all services, the JTCG/ME effectively supports mission accomplishment for our soldiers, sailors, airmen and marines.

As of January 1997, the JTCG/ME has distributed approximately 164 paper JMEMs, 371 special reports, and 771 foreign information releases. Since 1995, many JTCG/ME products developed by the working groups have been distributed via electronic media. These CD-ROMs or diskettes are stand-alone products and accompany JMEMs. There are three published CD-ROMs: 1) JMEM/Air-to-Surface Weaponeering System (JAWS), 2) World Artillery and Mortar Systems (WAMS), and 3) Special Operations Target Vulnerability and Weaponeering Manual. Currently under production are two more CD-ROMs: 1) Joint Anti-Air Combat Effectiveness (J-ACE) and World Infantry and Tank Systems (WITS). Each CD-ROM product provides a single source of information on weapons effectiveness against specific targets, to include available effectiveness data and the methodologies used to generate the data. This presentation (and demonstration) will focus on one of the hypertext document CD-ROM products, either the JAWS or the WITS.

Thursday, 0830-1000

COMPOSITE GROUP E SESSION .... Room I-122

Thursday, 1030-1200

The Necessity for Integrating Space Assets into Campaign Analysis

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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, & analysis (MS&A) community must take a hard look at the design and implementation of the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrowís models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Linking MOEs to a Composite Measure of Success: A Case Study from the SAIP Assessment

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Researchers in automated target recognition (ATR) technology have investigated methods for automatically extracting information from imagery data and conveying it to the warfighter. More recently, the emphasis has shifted: ATR algorithms are being used as a tool to assist the imagery analyst, while leaving final decisions about image interpretation in the hands of the human. The Defense Advanced Research Projects Agency's (DARPA) Semi-Automated Imagery Intelligence (IMINT) Processing (SAIP) program is intended to demonstrate this assisted image exploitation capability to support the need for timely IMINT. To assess the military utility of the SAIP technology, measures of effectiveness (MOE) were proposed to quantify image exploitation performance. These metrics address the correctness and completeness of the IMINT reporting, the timeliness of the intelligence, the imagery throughput for the system, and changes in these metrics arising from analyst fatigue. To determine the overall military utility of the SAIP technology, a methodology was needed to aggregate these metrics into an overall Measure of Success (MOS). The proposed solution is a decision process, using Saaty's Analytic Hierarchy Process (AHP) and based on representative military scenarios. A panel of military experts was convened to provide the ratings for the AHP. A simulation model, depicting the search for SCUDs based on various image exploitation capabilities, offers a way to illustrate the relationship between military utility and the MOS. The full application of this process allows for an objective assessment of the utility of SAIP technology for military users.

Modeling and Simulation for DD 21

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Thursday, 1330-1500

Development of a Combat Potential Metric for Air Combat Command

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Mine's Bigger Than Yours: Taking the Measure of MOEs and MOPs

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Negating the Threat: Replacing Attrition Reduction MOEs in the Post Cold War Era

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Approved abstract unavailable at printing.

WG 25 – TEST AND EVALUATION - Agenda

Chair: Blair J. Budai, 445th Flight Test Squadron
Advisors: Dr. Marion Williams, AFOTEC/CN
Wink Yelverton, Chief, EO/IR Systems Branch
Cochairs: CDR Mary Jo Zurey, COMOPTEVFOR
Michelle Kirstien, HQ AFOTEC/TSI
Dr. Ernie Montagne, BDM Engineering Services Co
Dr. Gene Dutoit, Dismounted Battlespace Battle Lab

ROOM: I-322

Tuesday, 10:30 – 1200, Test Concept
Joint Countermine Advanced Concept Technology Demonstration (JCM ACTD)
LCDR Paul E. Karlsson, COMOPTEVFOR

Continuous Process OT&E Conceptual Model
LTC Edward F. Teigeler, HQ AFOTEC

Commercial Best Practices and the DOD Acquisition Process
Robin L. Frost, DTSE&E/SE, Anne M. Patenaude, Science Applications International Corp.

Tuesday, 1330-1500, Verification, Validation, and Accreditation
Linking Effectiveness Measures and Simulation Validation Criteria—Techniques for Defining "Good Enough"
Dr. Frank B. Gray and Maj. Suzanne M. Beers, Office of the Chief Scientist, AFOTEC

USMC Joint Simulation System (JSIMS) Operational Testing Strategy
Peter H. Christensen, The MITRE Corp.

Results of the DoD Validation, Verification and Certification (VV&C) Tiger Team
Maj. Bill Norton, AEDC/XP, Dave Thomen, SAIC

Wednesday, 0830-1000, Operational Test
Availability: Making It Work for Navy Testing of Multi-mission Systems
Kevin C. Smith, COMOPTEVFOR

Innovations in the Operational Test and Evaluation Process
LCDR Mark Thompson, Joint Interoperability Test Command, and Dr. Ernest Montagne, BDM

Evaluation Event for Advanced Joint Planning (AJP) Advanced Concepts Technical Demonstration (ACTD)
Terry McKearney and Steve Burchard, Kapos Associates Inc.

Wednesday, 1030-1200, Navy Operational Test
Current Issues in Operational Testing for Navy systems
Dr. David S. Mazel, COMOPTEVFOR

Reliability vs Availability in Software Intensive Systems
CDR Darrel Westbrook, COMOPTEVFOR

Practical Sequential Design Procedures for Submarine ASW Search Operational Testing: A Simulation Study
Dr. Steve Warner, Institute for Defense Analyses

Wednesday, 1330-1500, Flight Test
F-22 Modeling, Simulation, and Flight Test: A 21st Century Cockpit Perspective
Bruce P. Hunn, F-22 CTF

Store Separation Analysis Using Modeling to Determine Six Degrees of Freedom
William B Thacker; Computer Sciences Corp.

Codifying AFOTEC Rapid Test and Assessment Processes
Maj. Mark Waltensperger, HQ AFOTEC/TSX

Thursday, 0830-1000: Data Analysis
Analytical Derivation of Mission Capable Rate
Maj. Randall L. Riddle, HQ AFOTEC/SAL

Identifying Performance Drivers for Theater Missile Defense
Barry L. Mitchell, The Johns Hopkins University

New Methods or Old Statistics?, A Comparison of Techniques
Maj. Suzanne M. Beers and Dr Frank B. Gray, HQ AFOTEC

Thursday, 1030-1200, Modeling and Simulation
Modeling and Simulation Support of C4I Systems Testing
Kenneth Thomas, Joint Interoperability Test Command

Issues in Operational Test and Evaluation of Information Assurance Vulnerabilities
Jeffrey Ball, Institute for Defense Analyses

Versatile Information Systems; Integrated, On-line, Nationwide (VISION)
Dr. Samuel Harley, Aberdeen Test Center

Thursday, 1330-1500, Data Analysis - Logistic Issues
Testing Advanced Distributed Simulation for T&E
LTC Patrick M. Cannon, Joint Advanced Distributed Simulation Joint Test Force

Reliability and Maintainability Growth of the C-17
Dr. Jeffrey E. Schofield, Institute for Defense Analyses

Use of Phusics of Failure to Promote Commercial Technology Insertion And to Reduce Sustainment Costs
Jane Krowlewski, USAMSAA

Alternates

Modeling and Simulation Support for USMC Anti-Tank Missile Testing
Peter H. Christensen, The MITRE Corp.

An Operational Perspective of the Electronic Combat Data Exchange
John Crane, Sverdrup Technology, Inc.

When Systems are Simulations – T&E, VV&A, or Both?
Priscilla A. Glasow and Michael Borowski, The MITRE Corp.

In Pursuit of M&S Standards
Lana McGlynn and LTC Donald Timian, Army Model and Simulation Office

Test and Evaluation of Evolutionary Software Systems
Ellen H. Snook, HQ TEXCOM

Electronic Warfare Mission Data Optimization, A Different Approach
Jerry D. Sowell, 53d Wing/68ECG/36ETS/EEC

21st Century Surface Combatant (SC-21) Program
John Bailey, NSWC Dahlgren Division

Analysis Methods for Complex C4I Systems
John S. Furman, The MITRE Corp.

The Use of Operational Modeling and Simulation in Test, Evaluation and Wargaming: GPS on the Battlefield
Steve Friedman, Veridian, and 2LT David Ozmen, SMC/CZE

WG 25 – TEST and EVALUATION – Abstracts
ROOM: I-322

Tuesday, 10:30 – 1200, Test Concept

Joint Countermine Advanced Concept Technology Demonstration (JCM ACTD)

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Advanced Concept Technology Demonstrations (ACTD) are becoming an effective means of speeding cutting edge technologies to the fleet. The Joint Countermine Advance Concept Technology Demonstration (JCM ACTD), sponsored by CINCUSACOM, was one of the first ACTDs to be initiated and has become the test-bed for developing the policies and expectations of ACTDs in general. Putting cutting-edge technology in the hands of the war fighter for evaluation very early in its development has proven very effective in identifying potential for military utility. By eliminating systems that show no promise of military utility, test and evaluation efforts have been able to concentrate on expediting those technologies that will be an improvement over our current capabilities.

As of Desert Storm, our country's ability to "kick down the door" and go ashore had not improved significantly since World War II. During the Gulf War, our ineffectiveness in countermine operations in the Very Shallow Water (VSW) became apparent when valuable war fighting assets could not be brought to bear. The services have been challenged to quickly correct this deficiency. Our response has been a joint Navy, Army and Marine Corps initiative known as the Joint Countermine Advanced Concept Technology Demonstration (JCM ACTD). It has effectively encouraged the rapid development of a system of overlapping systems that together have proven their potential to detect and negate mine threats seamlessly and in-stride with the amphibious landing force.

Continuous Process OT&E Conceptual Model

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This paper proposes a new conceptual model of the processes used to accomplish operational test and evaluation (OT&E). The traditional process model for OT&E is a linear concept with OT&E serially progressing through phases of program identification, advanced planning, test planning, test conduct, and test reporting. The Continuous Process OT&E Model is a three dimensional conceptual model relating eight OT&E processes conducted concurrently and interactively throughout the entire acquisition cycle. This model is analogous to the systems engineering process used in program development. The eight key transformational processes include the following: 1) Active participation in the operational requirements process, 2) Characterize the operational environment, 3) Monitor the acquisition program, 4) Test planning, 5) Forecast and obtain resources, 6) Develop OT&E methods, policy, tools, and resources, 7) Conduct testing and analyze results, and 8) Report results. Specific inputs, outputs, and outcomes related to the key transformation process are presented relative to the conduct of space and missile system OT&E for the U. S. Air Force. Quality measures and suggestions for change in adapting OT&E for the future will also be briefly presented.

Commercial Best Practices and the DOD Acquisition Process

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The Defense Department envisions an acquisition process supported by the robust, collaborative use of simulation technology that is integrated across acquisition phases and programs. The objectives of Simulation Based Acquisition (SBA) are to:

(1) Reduce the time, resources, and risk associated with the acquisition process;
(2) Increase the quality, military utility, and supportability of systems developed and fielded; and
(3) Enable integrated product and process development from requirements definition and initial concept development through testing, manufacturing, and fielding.

It is clear that integrated product and process development, backed by a strong commitment to computer-based modeling and simulation tools, provides a dominant and competitive edge in the commercial marketplace and a distinct warfighting advantage on the battlefield. It provides an alternate path for getting to market first, at lower cost. In the process, quality is improved. The underlying technology is widely available, and market forces are driving industry toward simulation-based acquisition. So what is needed to fully embrace this approach? This presentation will include discussion on the SBA framework being established by DoD and Industry.

As a cornerstone of Simulation Based Acquisition, DTWSE&E and DOTE are jointly sponsoring a major initiative to increase T&Es value to the acquisition process in a move from a traditional test-fix-test approach to a model-simulate-test-iterate approach, fixing after each problem is found. This is known as the Simulation, Test and Evaluation Process (STEP) and changes significantly the way in which M&S is integrated with T&E. With STEP there are anticipated payoffs in program cost savings, development schedule and productivity, and improved mission performance. It is a process that integrates both simulation and test for the purpose of evaluating the performance, military worth, or effectiveness of systems to be acquired.

Tuesday, 1330-1500, Verification, Validation, and Accreditation

Linking Effectiveness Measures and Simulation Validation Criteria—Techniques for Defining "Good Enough"

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As simulations play increasingly larger roles in weapon system acquisition programs, one might expect a corresponding increase in the need for quantitative, versus qualitative, validation of those simulations. Here we develop objective techniques for relating operational effectiveness measures to observable parameters, so that operational requirements can drive how well the pieces of a composite simulation must perform. These techniques are useful when the performance of individual mathematical models from which a composite simulation is constructed can be compared to the entity that is modeled, but outputs of interest from the simulation cannot. For example, when enemy weapon system performance is simulated we can usually validate that the pieces of a system are modeled properly, but we can't actually shoot at our systems (e.g. airplanes) to see how well the overall simulation works. The techniques presented here use fuzzy set theory and Dempster-Shafer evidential reasoning to link bounds on unobservable operational performance criteria to bounds on observable functional level performance. Three situations are considered. The first is when there is some limited data available for the actual scenario being simulated. The second is when data on a similar scenario are available. And the third is when no data are available. Examples are given that demonstrate how these techniques provide improvements over TLAR (that looks about right) validation criteria.

USMC Joint Simulation System (JSIMS) Operational Testing Strategy

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The Marine Corps Operational Test and Evaluation Activity (MCOTEA) has been tasked to conduct Operational Testing (OT) of the Joint Simulation System (JSIMS). Major components of JSIMS include simulation objects, interfaces to real world C4I systems, and a simulation infrastructure based on the DMSO sponsored High Level Architecture (HLA). The USMC JSIMS OT strategy will employ a unique approach to conduct OT. The Marine Corps intends to develop a test plan that exploits concurrent Verification and Validation (V&V) and combined Development Testing (DT) and OT.

MCOTEA and the Marine Corps Systems Command (MARCORSYSCOM) have established a Memorandum of Agreement (MOA) for testing software intensive systems. Some of the items defined by the MOA include software metrics, requirements traceability, and risk assessment. JSIMS will be a software intensive system and will need to satisfy the metrics defined in the MOA. The USMC JSIMS OT strategy must also comply with the MOA. As part of the OT strategy, USMC JSIMS will be tested incrementally in several builds with concurrent DT/OT.

The JSIMS Test and Evaluation Master Plan (TEMP) states that testing results may be used to support V&V for cost savings. MCOTEA will monitor the V&V process to ensure that the JSIMS design matches Marine Corps requirements, the software implementation matches the JSIMS design, and that the final software implementation tracks back to the requirements. Three Collaborative Events (CEs) will be conducted to support combined DT/OT prior to IOC (FY00). The results of tests from each CE will be reported in an Independent Evaluation Report (IER). The IER will identify additional areas of concerns and risks which may be addressed in subsequent Software Integration Tests (SWIT) and System Tests for follow-on CEs. Thus, the USMC JSIMS OT Strategy will leverage off of concurrent V&V and the combined DT/OT Test Concept to achieve a thorough test, within current monetary and time constraints.

Results of the DoD VV&C Tiger Team

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Directives within the US DoD mandate that each component establish Verification, Validation and Accreditation (VV&A) policies for models and simulations (M&S). As a part of VV&A, it is necessary to perform Verification, Validation and Certification (VV&C) of the associated data. Current *ad hoc* methods to acquire, access, and VV&C data for M&S application can be costly, inefficient, and may results in questionable credibility of the data. In an environment that stresses the criticality of M&S results, quality data is as important as the performance of the M&S themselves. However, VV&C is not at a stage of general understanding and practical implementation within DoD. A summary of relevant issues, efforts to date, and recommendations for moving forward as a community are needed. To address this need, a Tiger Team was established, with membership drawn from the DoD components and made up of representatives from the M&S functional domains. The stated objective of the team was to develop a common technical foundation for VV&C to support preparation of tailored policies and implementation action plans by each DoD component. The Tiger Team focused on data user VV&C and its association with VV&A. It examined present processes, guidelines and practices used in the conduct of VV&C activities. After having assessed what has been done to date to encourage VV&C throughout the DoD M&S community, the Team considered what remains to be done, and recommended actions to further this outcome. The results of the Tiger Team will be summarized in this paper.

Wednesday, 0830-1000, Operational Test
Availability: Making It Work for Navy Testing of Multi-mission Systems

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A critical operational issue that we test is availability. In the past, we've found that people within and without the testing community have considered the availability of subsystems as independent probabilities for multi-mission systems. Furthermore, we've seen that many people have tried to test components of availability of a multi-mission system at separate testing times. In this paper, we discuss a different approach that we have adopted for testing this operational issue.

Our paper begins with a brief look at past ideas on availability. We show why past views fall short for current testing, and, indeed, were never appropriate for many areas of testing. We illustrate these failures with several examples where past methods would lead to erroneous conclusions.

We then put forth our methodology where we look at availability on a multiple time-line basis. We show that to test the availability of a multi-mission system (or system of systems) we must test with a focused time-line that looks at all the subsystems under test simultaneously. It's not enough to test one system at a time and then, somehow put the results together later. We then illustrate this approach with a graphical time-line and several examples.

Next, we present the concepts of fully mission capable and partially mission capable. These concepts, defined prior to a test, allow us to introduce flexibility in our tests while maintaining a high level of experimental control.

Lastly, we present examples to illustrate these ideas from current programs such as DD-21 (the land attack destroyer) and ring laser gyro navigation system for submarines.

Innovations in the Operational Test and Evaluation Process

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To support OT&E of the Global Command and Control System, the Joint Interoperability Test Command (JITC) developed and implemented several features to streamline the process. This paper will describe our successes and lessons learned with these features:

- Using risk assessments to determine scope of tests
- Integration of DT and OT
- Subject matter expert (SME) assessment of Mission Task Success as the principal MOE.

For GCCS Version 2.2 and GCCS (Top Secret), JITC successfully applied Department of Defense guidelines for OT&E of software-intensive systems. JITC assessed risk based on mission impact and likelihood of failure to meet each requirement; the level of risk determined the level of testing. The user community provided input on mission impact of failure to meet each requirement. JITC assessed likelihood of failure. The benefits of this approach were:

- significant user participation in the test process
- acceleration of the test process
- level of testing commensurate with risk.

For GCCS Version 3.0, the JITC OT&E concept incorporated several features that enhanced operational realism:

-JITC ensured a strong operational flavor in the DT program by incorporating user
- personnel in the DT process.

As a result, DT data significantly supported OT, reducing OT requirements.

The user community participated significantly in the JITC's OT process. The user community provided input to determine an operationally realistic OT scenario consisting of a series of Mission Tasks, and the user community provided SMEs to assess the principal MOE, Mission Task Success.

Evaluation Event for Advanced Joint Planning (AJP) Advanced Concepts Technical Demonstration (ACTD)

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The Advanced Joint Planning (AJP) ACTD was a joint DARPA - CINCUSACOM-sponsored ACTD intended to develop an automated, collaborative joint planning system based on leading edge command, control, communications, computer and intelligence (C4I) technologies. In view of the difficulties inherent in attempting to conduct an operational evaluation of the AJP ACTD technologies in conjunction with an already scheduled USACOM exercise, the authors developed the concept of a dedicated "Evaluation Event." During the Event, military planners from CINCUASCOM and subordinate commands would utilize the AJP technologies in an integrated scenario-driven attempt to generate the key products required by the standard military planning process for crisis action planning (CAP) as outlined in the Joint Operational Planning and Execution System (JOPES) doctrine and pertinent CINCUSACOM directives.

To insure the venue provided by the Event was adequate to support the analysis required, the Event was based on the: (1) a structured

environment in which military personnel proficient in the use of the AJP technologies and crisis action planning could conduct an interactive, collaborative planning process utilizing the technologies in a realistic effort to develop military courses of action (COAs) in response to a scenario reflecting the demands of contemporary military operations; (2) a thorough data collection effort capable of capturing and measuring the utility of the AJP technologies at supporting joint military planning process for COA development. In order to develop a generic CAP process for evaluation, the six phase JOPES CAP process was aggregated into three operational threads considered essential for the CINC and JTF staffs to accomplish in CAP. From these threads, a series of 16 separate exercises was scripted for inclusion in the Evaluation Event. For purposes of data collection and Evaluation Event management, these exercises were further decomposed into 133 discrete tasks, each describing the actions to be taken by users in specific roles (CINC JPG, JTF JPG, component commander, etc.) in completing the exercise.

While the ACTD paradigm calls for rapid development and fielding without the time and funding necessary for traditional operational testing and evaluation, the need to safeguard resource expenditure is obvious. The AJP ACTD Evaluation Event demonstrated a methodology for command and control technology evaluation in a synthetic yet rigorous environment which focused on the operational capabilities of the ACTD technologies in an integrated fashion. Key lessons learned in this process are pertinent to developing metrics for evaluating command and control systems and conducting focused but relevant evaluation within limited resources.

Wednesday, 1030-1200, Navy Operational Test

Current Issues in Operational Testing for Navy Systems

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In this paper we look at many of the current issues that effect Navy operational testing today. To begin, operational testing is under constant pressures such as lean budgets, tight schedules, and fewer testing assets. These factors severely restrict the conduct of tests and the insights we can gain from testing. In this paper we explore these issues.

The first part of our paper begins with a look at what we mean by operational testing compared to developmental testing. We look at both the testing environment and the assets we need for operational tests. In particular, we discuss why operational testing is crucial to system testing. Then, we turn to issues such as cost limitations, schedule restraints, statistical significance of current tests, the use and availability of real targets, and finally to the role we see for modeling and simulation.

The last part of our paper looks at particular system examples where we highlight these issues. These examples include SLQ-32 software, the Giant IR infrared decoy system, the Rapid Air Integrated Defense System (RAIDS), and the Nulka seductive decoy system.

Reliability vs Availability in Software Intensive Systems

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Operational testers are tasked to assess the operational effectiveness and operational suitability of the systems they evaluate. Operational effectiveness is associated with the measurable warfare performance improvements specified in the operational requirements document (ORD), whereas operational suitability is a measure which encompasses several areas typically related to the support of the system. Within recent years, most of the short comings in many operationally tested systems, especially those which leverage heavily upon commercial-off-the-shelf technology (COTS), can be attributed more to suitability issues than effectiveness ones. Although they are not any more important than other suitability measures, the key suitability metrics have historically been reliability, maintainability and availability. Testers and developers face a dilemma when testing software intensive systems that achieve or exceed required availability thresholds, but fail reliability. To fully understand this dilemma these two metrics must be examined.

This paper will evaluate the merit of operational reliability versus operational availability for software intensive systems. A discussion of the techniques used to compute availability and reliability will be presented and several examples that depict the issues surrounding the use of one metric over the other will be examined.

Practical Sequential Design Procedures for Submarine ASW Search Operational testing: A Simulation Study

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The efficient design of a free-play, 24-hour-per-day, operational test (OT) of an ASW search system remains a challenge to the OT community. It will often be the case during an ASW search OT that artificial means of detecting the target are introduced in order to speed up the detection process. When used, these various artificial means of speeding up the detection process severely affect the realism of the search OT and limit the usefulness of the collected data. However, if these artificial procedures are not used, the OTD is faced with the problem of controlling the average length of time that a test event lasts.

This presentation will identify test control rules that an OTD can employ from on-board the searching platform to allow for an efficient, realistic, free-play, 24-hour-per-day OT. The basic test control premise described here is to stop the test event if the time without a

detection/classification grows too long. Furthermore, if this long period passes again without detection/classification, then the OTD uses a different search scenario in which the size of the area being searched is shrunk.

This presentation will focus on the results obtained by simulating an ASW search OT in which test control rules were applied. The ramifications of the use of these various test control rules on the number of trials expected (for a given test duration), the test duration (for a given number of required trials), and on the quality of the estimates of search-related measures of effectiveness will also be discussed.

Wednesday, 1330-1500, Flight Test

F-22 Modeling, Simulation, and Flight Test: A 21st Century Cockpit Perspective

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The F-22 Advanced Tactical Fighter Cockpit was designed to provide unique capabilities in a combat aircraft well into the 21st century. An example of this capability is demonstrated by the cockpit's displays. These displays, in contrast to many existing aircraft, employ sensor fusion which is the combination of information received from a variety of sensor sources that is then presented to the pilot, in an integrated form on one or more displays. This information, also in contrast to most aircraft of today, can be highly configured by the pilot to suit their individual preferences and mission needs. In keeping with the advances within this cockpit, the test and evaluation of this aircraft also includes advances in the test and evaluation process. These changes were driven by acquisition reform, and represent a major shift in perspective from previous acquisition programs. The primary change for this cockpit was reliance on a four tiered approach of; pre-construction modeling and simulation, real-time simulation, flight test, and post-construction full combat simulation. While all modern aircraft use pre-construction modeling, simulation and then flight test, the inclusion of real-time simulation and post-construction full combat simulation is innovative. The purpose of this paper is to discuss the advantages of this approach and to demonstrate how each stage is not only critical, but also how each contributes to overall system effectiveness for the program. The test and evaluation plan for this aircraft may also serve as a representative model of how any program can deal with major impacts to cost, while managing risk and improving system effectiveness.

Store Separation Analysis Using Modeling to Determine Six Degrees of Freedom

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Store separation analysis represents a critical element in evaluating an object; such as a store, missile, or fuel tank, as it leaves an aircraft. Use of the Edwards Store Separation Analysis System (ESSAS) used at Edwards AFB, is a core activity of this process. The ESSAS was developed by Mr. Smith and Mr. Barrett at Eglin AFB.

Once an object has separated from the aircraft the position and attitude are important to verify safe separation. The attitude and position, or trajectory of ESSAS data, can be used to validate modeling and simulation data, such as that performed in a wind tunnel test. The ESSAS has been used to validate modeling and simulation data on several store separation programs over the past 10 years, and from this we have learned that ESSAS accuracy is plus or minus 2° and 2 inches.

The analysis process uses 16 mm or 35 mm film taken during the separation, which is converted into digital image data for analysis. Each image is displayed along with a superimposed computer-generated model of the released object. An operator aligns the model with each image to determine the attitude and position of the object with respect to each on-board camera. This matching process is repeated with as many camera views as necessary (or available) of the store separation to accurately match the wire-frame model in all six degrees of freedom (X, Y, Z, Yaw, Pitch, Roll). The ESSAS software is then used to determine the trajectory of the object with respect to the aircraft to approximately 20 feet below the aircraft.

Due to the shrinking budgets associated with flight testing of aircraft, more and more modeling and simulation data will be used to reduce the cost, especially in the area of store separation. As we turn to more modeling and simulation processes we will need to rely on a truth source such as ESSAS to validate the accuracy's of modeling and ensure safety of flight.

Codifying AFOTEC Rapid Test and Assessment Processes

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Historically, the Defense Evaluation Support Agency (DESA) has very successfully conducted short duration, demonstrations, evaluations and quick-look assessments for a select Department of Defense customer base. On 1 October 1997 DESA became a two-letter directorate of the Air Force Operational Test and Evaluation Center (AFOTEC). DESA is now designated AFOTEC/TA (Rapid Test and Assessment). Classical TA evaluation methods and test processes are considered atypical when compared with standard AFOTEC procedures and methods. AFOTEC identified a requirement to codify, document and ultimately disseminate TA methods because of the unique nature of their processes and their success in satisfying customer needs.

An interdisciplinary team drawn across AFOTEC functions conducted an operational analysis of TA processes and methodologies. First, a review of all pertinent final reports was conducted. All policy documents were examined and extensive interviews were conducted

across all functional TA areas. Actual tests were observed. Test process data were then compared against traditional test methodologies and against internal TA perceptions for conducting, analyzing and reporting test results. The final product will include a codification of TA processes, which will be disseminated for HQ AFOTEC application. This research is work in progress.

Thursday, 0830-1000: Data Analysis
Analytical Derivation of Mission Capable Rate

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Mission Capable Rate (MC) is an availability metric often used to make comparative assessments of existing weapon systems and to evaluate new procurements. Historically, the MC of new procurements is estimated by collecting limited test data to characterize reliability and maintainability, then using complex simulations to apply these characterizations to multiple systems operating over long periods of time. In many applications, a large number of simplifying assumptions must be made regarding spares levels, maintenance manning, usage rates, and process delay times. An analytical derivation of MC rate is developed using these same simplifying assumptions to obviate the need for complex model development in these situations. MC is characterized as a function of the independent variates time between critical failure and repair time, and deterministic values logistics delay time and utilization rate. The nature of MC as a dependant variate is briefly discussed. Assumptions are outlined and the resulting limitations of the derivation are discussed in depth. The analytical formulae for MC mean point estimate, variance point estimate, and mean confidence bounds are presented. Results are compared to historical data and simulation results.

Identifying Performance Drivers for Theater Missile Defense

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The authors have developed a methodology to quantify confidence in Theater Missile Defense performance by overcoming modeling deficiencies in the primary BMDO force-on-force simulations, the Extended Air Defense Testbed (EADTB) and the Extended Air Defense Simulation (EADSIM). Sensitivity analysis is an essential element of this methodology. The goal of sensitivity analysis is to better characterize system behavior by identifying key performance drivers. Once the drivers are known then parameters of lesser importance can be ignored in future Monte Carlo analysis. The authors employed a random balance approach to conduct the sensitivity analysis (rather than a more traditional fractional factorial approach) because the ballistic missile defense problem is supersaturated, that is, the number of stochastic factors exceeds the number of design points that can be efficiently evaluated with digital simulation.

This presentation discusses the methodology and shows results of sensitivity analysis conducted for two important, and fundamentally different, warfare theaters. Main effects and two-factor interactions are computed for a variety of timeline, accuracy, and reliability factors. The results have clear implications for architectural design studies and for the development of efficient and effective Concepts of Operations (ConOps) for ballistic missile defense systems. Feedback of these results to the test community will help identify risk and guide test resource expenditures.

New Methods or Old Statistics?, A Comparison of Techniques

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Arguments rage within academic and analysis communities over the strengths and weaknesses of the "new" or "intelligent" techniques, such as Dempster-Shafer Theory of Evidential Reasoning or Fuzzy Logic, in contrast to more traditional, "standard" probabilistic and statistical techniques. This paper presents a comparison of these techniques by analyzing the properties of a "sample" urn, drawn from a "population" urn. The sample urns are drawn using a variety of sampling techniques (e.g., random draw with replacement, random draw without replacement, biased draw, etc.), yielding various sample characteristics. In addition to various sampling techniques, the description of the elements within a sample will be varied (e.g., ranging from simple measures of the color of the ball in the urn (representing a Bernoulli distribution) to more detailed descriptions of the underlying characteristics of the elements). After sample urns are created, each is analyzed using Dempster-Shafer, fuzzy logic, probabilistic, and statistical methods. Conclusions are drawn on the adequacy of each technique, given the sample-to-population relationships and the characteristics of the description of the elements within each sample. These conclusions are used to select analysis techniques for different T&E scenarios.

Modeling and Simulation Support of C4I Systems Testing

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The Joint Interoperability Test Command (JITC), located at Fort Huachuca, Arizona, is responsible for interoperability certification of all joint command, control, communications, computers, and intelligence (C4I) systems. The Joint Interoperability Evaluation System (JIES) is a key JITC tool for interoperability certification testing of joint tactical command and control systems, such as Airborne Warning and Control System (AWACS), AEGIS, and PATRIOT. During FY97, the JITC conducted 10 separate tests and certified 22 systems. JIES supports pre-test planning, test conduct over a distributed test network (called the Joint Tactical Data Link (JTDL) Network), and post-test analysis. JIES generates simulated radar images to stimulate the hardware-in-the-loop (HWIL) systems in the network, displays test messages for real-time verification of test event completion, and captures these messages for post-test data reduction and analysis of results.

To improve the operational realism of TADIL certification tests, JITC developed an interface between JIES and a commercial-off-the-shelf combat simulation model called CIMULS/SPECTS. The interface will operate in either an interactive or playback mode. In interactive mode, the simulation model can provide a realistic operational environment for certification tests. In playback mode, the model can support post-test analysis of "what if" and "so what" questions. The interface complies with Distributed Interactive Simulation (DIS) Protocol Data Units (PDU) standards. Because the interface is DIS PDU compliant, several models can be networked in the JTDL Network. JITC is investigating additional interfaces between JIES and two Government-off-the-shelf models, Extended Air Defense Simulation (EADSIM) and Simulated Warfare Environment Generator (SWEG).

In addition, JITC is developing interfaces between SWEG and the Global Command and Control System (GCCS), which is undergoing operational test and evaluation at JITC. In the future, JITC plans to incorporate high level architecture (HLA) features in all interfaces.

This paper will describe the status of JITC's initiatives to improve C4I system testing by incorporating constructive models into a HWIL distributed test network.

Issues in Operational Test and Evaluation of Information Assurance Vulnerabilities

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Information assurance (IA) vulnerabilities of DOD systems have been inadequately addressed during system development because of a serious underappreciation of the nature and extent of the problem, a lack of tools to properly evaluate a system's vulnerabilities, and costs. Also, the computer security structure within which to respond to a highly dynamic and rapidly maturing threat is exploitation of hardware, software, and protective tactics, techniques, and procedures. Test and evaluation in this area to date has been unstandardized from program to program and between the Services.

This presentation proposes a methodology for an improved operational evaluation of IA vulnerabilities. The concept includes evaluations that will be accomplished early in the development cycle, with continual updates throughout the employment life of information-dependent systems. The objective is to reduce the impact of an attack, and to ensure that the warfighter is aware of the capabilities, vulnerabilities, and limitations of his information systems, and able to develop appropriate tactics to mitigate IA vulnerabilities.

Systems that will require evaluation of their information vulnerabilities include:

Weapons systems that are dependent upon external information sources or that provide information to other DOD systems (e.g., ATCCS, JSTARS)

Computer-networked Command, Control, Communication, Computer, and Intelligence (C4I) and Automated Information Systems.

The presentation, in addition to describing the development of an operational evaluation methodology, will define work in progress on criteria or metrics, system IA requirements, and other prerequisites for conducting meaningful evaluations that provide visibility on a system's information assurance capabilities.

It also represents an introduction to the challenges of evaluating IA vulnerabilities during system development and test. The presentation includes:

A common IA OT&E policy for OSD and the Services.

A roadmap to guide development of IA OT&E tools.

A select number of case studies employing data from OT&Es and exercises to refine the policy and roadmap components.

Versatile Information Systems; Integrated, On-line, Nationwide (VISION)

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The 'tried and true" paradigms which have governed the test and evaluation its inception have become inoperative. In response to changing boundary conditions and rules of operation Aberdeen Test Center has developed the VISION concept. VISION evolved from the need to make cost effective use of all the system performance and employment information gathered during all phases of a systems life cycle,

and to organize all information such that it is reusable and thus applicable for multiple applications. A major challenge faced by the test and evaluation and training communities within DoD is to coordinate activities to maintain and increase the value added through T&E and training exercises in an environment of decreasing resources - related to both funding as well as battlefield system availability. The vision for integrated T&E and training is establish a cooperative of T&E and training organizations to provide seamless flow among the participants and to overlay the scientific method onto quasi-free play exercises to extract maximum information, effect rigorous testing (from a scientific point of view), and enable integrated training; to encompass virtual prototypes, validated models, system simulations, and military hardware and weapon systems; and to implement these provisions effectively and efficiently. To achieve this vision requires that issues of data modeling, data dictionary, exercise conduct, data acquisition, processing and display, real time feedback, level of control, and other issues be resolved.

Thursday, 1330-1500, Data Analysis - Logistic Issues

Testing Advanced Distributed Simulation for T&E

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This paper proposes a new conceptual model of the processes used to accomplish operational test and evaluation (OT&E). The traditional process model for OT&E is a linear concept with OT&E serially progressing through phases of program identification, advanced planning, test planning, test conduct, and test reporting. The Continuous Process OT&E Model is a three dimensional conceptual model relating eight OT&E processes conducted concurrently and interactively throughout the entire acquisition cycle. This model is analogous to the systems engineering process used in program development. The eight key transformational processes include the following: 1) Active participation in the operational requirements process, 2) Characterize the operational environment, 3) Monitor the acquisition program, 4) Test planning, 5) Forecast and obtain resources, 6) Develop OT&E methods, policy, tools, and resources, 7) Conduct testing and analyze results, and 8) Report results. Specific inputs, outputs, and outcomes related to the key transformation process are presented relative to the conduct of space and missile system OT&E for the U. S. Air Force. Quality measures and suggestions for change in adapting OT&E for the future will also be briefly presented.

Reliability and Maintainability Growth of the C-17

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Reliability and maintainability (R&M) statistics for new weapon systems require lengthy test periods and/or large sample sizes to build confidence in the calculations. However, developmental systems rarely have stable configurations, established trouble-shooting techniques, or well documented repair procedures. Test assets, time, and personnel are typically constrained, and operationally representative suitability data are often sparse during initial test and evaluation. Operational testers and acquisition decision makers often have only limited data available when evaluating system suitability. Initial test and evaluation of the C-17 provided a distinct exception. Twenty aircraft flew more than 15,000 hours before the full scale production decision. Analyses of these data and the various phases of the test program provide interesting insights into the influence of numerous factors upon the suitability statistics for a complex, multi-mission weapon system. This presentation will highlight the major analytical results.

Use of Phusics of Failure to Promote Commercial Technology Insertion And to Reduce Sustainment Costs

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This paper presents two physics-of-failure reliability assessment case studies on electronic circuit card assemblies (CCAs). For the first case study, CCAs in the tri-service ARC-210 radio were analyzed to predict potential failure mechanisms. Accelerated life testing was conducted on the CCAs and verified the physics-of-failure analysis. A point of interest is that this CCA had previously undergone traditional reliability testing and no problems were found. The significant logistics impact of this failure mechanism is highlighted. For the second case study, commercial CCAs in the Bradley Fire Support Team (BFIST) vehicle were analyzed to determine if the military environment would cause failures in the useful life of the system.

Both case studies concentrated on board-level failure mechanisms because these are most likely to cause failures in commercial CCAs in a military environment. The University of Maryland Electronic Packaging Research Center's CalcePWA software was used to perform vibration, thermal, and failure mechanism analyses. CalcePWA was used to calculate times-to-failure for each failure mechanism.

These case studies show that physics of failure allows informed decisions on the impact of electronic design on reliability and logistics. By performing these analyses, the ARC-210 radio's reliability was increased and the BFIST program's confidence in using commercial electronics was increased. The increase of reliability and the use of commercial electronics has greatly reduce the sustainment costs of these systems.

Alternates

Modeling and Simulation Support for USMC Anti-Tank Missile Testing

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Modeling and Simulation (M&S) has been used historically within the USMC to support training. The USMC is using M&S to support Developmental Test (DT) and Operational Test (OT) of the Predator Short Range Assault Weapon (SRAW). Limited assets often restrict or preclude developers and testers from thoroughly exercising weapons systems to mitigate risk. The USMC developed:

1. a prototype model of the Predator SRAW, and
2. a simulation environment that can be used to generate additional data for DT and OT

The Predator SRAW M&S System enables real-time testing using production representative components, custom interface software and a COTS object-oriented simulation environment. Predator Guidance and Control Unit (GCU) and Target Detection Device (TDD) software have been rehosted for software-in-the-loop (SITL) testing. SITL testing focuses on static and dynamic analysis using McCabe Tools™. Predator GCU hardware has been integrated for hardware-in-the-loop (HITL) testing. HITL testing focuses on verifying missile probability of hit and probability of kill.

Firing scenarios are planned against both fixed and moving targets in open battlefield conditions and during military operations in urban terrain. An analysis determined that 15 firings were required to provide statistically valid results. The Marine Corps selected the Army Material Systems Analysis Activity (AMSAA) to conduct independent verification and validation of the Predator SRAW M&S System. The Marine Corps Systems Command and the Marine Corps Operational Test and Evaluation Activity will accredit the system for its specific test objectives.

An Operational Perspective of the Electronic Combat Data Exchange

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This presentation and technical report describe the implementation of the Electronic Combat Data Exchange (ECDATX) data sharing initiative from an operational perspective. The ECDATX architecture of distributed data servers using Web technologies is providing both local and remote users near-real-time to access Electronic Attack (EA) engineering and test data collected during Performance Characterization Analysis (PCA) conducted on the Eglin AFB, FL ranges. The ECDATX architecture uses existing Secret Internet Protocol Router Network (SIPRNET) and Unclassified but Sensitive Internet Protocol Router Network (NIPRNET) with Network Encryption Systems (NES) communications links.

The Web server architecture uses hypertext links to all engineering and test data, as well as archived CD-ROMs available through the on-line CD-ROM Juke Box. The ECDATX Concept of Operation provides guidance for operation, maintenance and continued development of this data sharing initiative. Work is now under way by AFIWC/DBEP to integrate the ECDATX architecture into the AF/EWIO Jammer Effectiveness and Techniques Web initiative.

The architectural design and implementation were addressed in a 65th MORS Technical Paper describing the development and evaluation of the ECDATX data sharing concept and architecture. Since the successful evaluation of ECDATX in supporting the April 97 MOBCAP EAST PCA, ECDATX has provided continuous data sharing support for PCAs performed at Eglin AFB during the last year and has continued to expand the data sharing capabilities and user organizations supported.

When Systems are Simulations – T&E, VV&A, or Both?

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Modeling and simulation has traditionally been used to support the test and evaluation (T&E) of new programs. An earlier paper authored by Allen, Burleson and Glasow identified four cases for depicting the relationship of simulation to T&E. That paper initiated a dialogue on the similarities and differences between the T&E process and the Verification, Validation and Accreditation (VV&A) process which is used to assess the credibility of models and simulations.

This paper will address a fifth case in which the system under test is itself a model, simulation, or suite of models and simulations. In this case, the overlap of T&E activities with VV&A activities increases significantly. New theory is proposed to define the extent of that overlap and address the implications of Case 5 for conducting T&E and VV&A on a given model.

As an evolving hypothesis, this research has current applicability and is directly influencing a number of major programs, most notably

the Joint Warfare System (JWARS). As the flagship simulation for Joint Campaign Analysis, the initial experiences gained from the Joint Warfare System (JWARS) effort will provide insightful lessons as to how the closely related, and often overlapping, VV&A and T&E processes can be implemented effectively. Valuable recommendations will be provided to aid the system sponsor in ensuring required system performance and on-time delivery, without unnecessary duplication of quality testing.

In Pursuit of M&S Standards

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Standards Development within the Army's M&S processes is a vital step toward achieving the economies, efficiencies and technological potential M&S represents. Through standards, the Army's M&S community shares techniques, procedures, processes, and applications. It builds on the work of others and advances the art and science of M&S in tandem with technological advances. Thus standards development is an iterative and consensus based process. This ongoing process consists of 18 standards categories which directly support achievement of the Department of Defense M&S objectives.

Test and Evaluation of Evolutionary Software Systems

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The Aviation Mission Planning System (AMPS) is a software-intensive mission planning and battle synchronization tool designed for the Army aviation brigade and below. As a mission planner, the AMPS automates key planning tasks and provides for loading of pertinent mission data directly onto modernized Army helicopters. As a battle synchronization tool, the AMPS will facilitate the aviation planning process with an electronic link to the Maneuver Control System for receiving higher-level mission information.

Because of the AMPS interface to multiple information and weapon systems, AMPS is an evolutionary acquisition program. A "core" system and known incremental functions are defined in the Operational Requirements Document, but final requirements continue to be refined.

Guidelines for test and evaluation (T&E) of software systems are provided, and those activities required for a Milestone III decision review and initial fielding are well defined. Guidance also is provided for post-fielding T&E considerations. But the process relies on the T&E and integrated product teams to make informed judgment on the level of testing required to ensure that the system continues to support the users' mission and capability to employ the system. The T&E community is challenged to effectively plan, manage, and execute incremental T&E.

The AMPS team is meeting the incremental T&E challenge even before an Initial Operational Test (IOT). The "core" system IOT is being planned. At the same time, incremental developments are on-going as field and technology requirements emerge. So, considerations and planning for incremental T&E are already in progress.

Electronic Warfare Mission Data Optimization, A Different Approach

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Defines the differences between Electronic Warfare (EW) jamming techniques and EW Mission Data (MD) from an operational perspective. Discusses an approach to develop robust MD by the application of software tools to analyze internal waveforms created by various MD parametric sets. The objective is to develop a procedure to predict optimum MD sets when models and instrumented radar systems are not available.

Reviews the results of a recent multiple service application of this approach to a system "hardened" against conventional jamming waveforms.

21st Century Surface Combatant (SC-21) program

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The 21st Century Destroyer (DD 21), the first ship class of the SC-21 family, will be radically different from its predecessors in both

design and acquisition process. It will be required to be more capable in many ways at much less cost with much reduced manning. This briefing describes the requirements for the ship and some of the innovative acquisition approaches now being pursued. Capabilities such as organic mine warfare, deep strike, reduced susceptibility to detection and attack, and others will make this a much different class of ships. Selected COEA results are used to show how requirements have been established.

It is one of the first major acquisition programs falling under the Simulation Based Acquisition requirements recently imposed by Secretary Gansler. This requirement is intended to capitalize on the use of modeling and simulation technology such as was used for the Boeing 777. Accordingly, the Request for Proposals, calls for the developers: *"To develop and deliver a DD 21 System prototype in Phase II, the Smart Product Model (SPM). The SPM is a digital version of the ship system, consisting of product model data and performance and behavior characteristics of the ship.* A description of the SPM concept and potential benefits will be given, based on the program's M&S Master Plan.

Analysis Methods for Complex C4I Systems

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The analysis of highly complex modern battlefield C4I systems is a non-trivial task and an underdeveloped science. C4I systems have traditionally been evaluated for effectiveness at the system level, by examining measures of goodness such as timely, accurate, and complete information delivery within the domain of the system alone. There are few or no good Measures of Effectiveness that directly correlate the performance of C4I systems to the combat effectiveness of the formations they control. As a result, the combat contribution of C4I improvements is often underestimated in traditional effectiveness analysis. To be successful, analysis techniques must relate C4I system-level performance to battlefield outcomes gained by the parent organization. This presentation will describe techniques used to link C4I system performance, staff performance, and battle outcome during an analysis of the Army's Division Advanced Warfighting Experiment. These findings will be translated into lessons learned applicable to the general topic of analyzing large C4I networks.

This paper establishes a methodology for the examination and quantification of the performance of C4I systems in an operational context. This methodology proposes second-order MOE that quantitatively link C4I systems capabilities to the battlefield efficiency of ground forces operations. The primary focus of the methodology is on tracing the execution of mission threads throughout the fabric of the battlefield during key phases of the battle, and thereby linking the system performance metrics of the C4I processes and hardware to the accomplishment of specific battlefield tasks. In this way the battlefield outcomes that are traditionally measured when assessing ground forces effectiveness can be directly linked to the C4I system performance characteristics.

The Use of Operational Modeling and Simulation in Test, Evaluation and Wargaming: GPS on the Battlefield

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GPS provides the Warfighter with precise position, velocity and timing information on the battlefield. This information can give the U.S. and Allied Forces a decisive advantage in navigation, communications, force enhancement, and precision weapons employment. Recently, studies have investigated the effects of a challenged EW environment on the operational use of GPS-aided weapon systems. This paper addresses the use of modeling and simulation to assess the impacts of this environment on the battlefield and how these same methods can be used to enhance operational and developmental test and evaluation, as well as to support exercises and wargames. An analytic approach for constructive modeling will be outlined, along with potential applications for virtual and live simulations.

WG 26 -- ANALYSIS OF ALTERNATIVES -- Abstracts

Chair: LtCol Philip J. Exner, OSD PA&E
Co-Chair: James Cooke, OSD PA&E
Advisor: Mr. Thomas L. Gibson, OSD PA&E

Room: I-260

Tuesday,23 June, 1030-1200
Measurement of Military Capability
Dr. William H. Jarvis and Col. Colin Lampard, USMC, Force Planning Division, OSD, PA&E; and Dr. Stan Horowitz, Institute for Defense Analysis

AOAs and COEAs: The Good, the Bad, and the Ugly
Mr. James C. Cooke, OSD, PA&E

Tuesday,23 June 1330-1500
Army Analyses of Alternatives Framework
Mr. John A. Riente, Technical Advisor to the Army Deputy Chief of Staff for Operations and Plans

Judging AoAs: Criteria for Producing Quality AoA Study Plans and Final Results
Christopher A. Feuchter, Office of Aerospace Studies (OAS), Kirtland AFB

Wednesday,24 June, 0830-1000
UH-1N Helicopter Upgrade / Replacement Analysis of Alternatives
Mr. Brian Milburn, Civ Senior Analyst, ANSER Aerospace Operations Division

Carrier Air Wing Capabilities Assessment
Cdr. Kim McEligot, Dr. Robert Hubbard, Mr. Adam Davidson, and Cdr. Charles Frye, CINCPACFLT

Wednesday, 24 June, 1030-1200
Airborne Mine Neutralization System Analysis of Alternatives
John Benedict, Johns Hopkins Applied Physics Laboratory and Mr. Ken Montgomery, Carderock Division Naval Surface Warfare Center

Quantitative Decision Support for Upgrading Complex Systems of Systems
Dr. Ronald R. Luman, Applied Physics Laboratory, Johns Hopkins University

Wednesday, 24 June, 1330-1500
Alternatives for Enhancing Aircraft Survivability: An Application of Exploratory Analysis
Dr. Bart Bennett, Mr. Jeff Hagen, Dr. Jim Chow, Mr. Arthur Brooks, and Mr. Patrick Myrick , RAND

The Necessity for Integrating Space Assets into Campaign Analysis
Capt. James R. Hunter, USAF, Chief, Detailed Campaign Analysis, and Capt. Mark A. Powers, USAF, Chief, Space Utilization & Operations, SMC/XR, Systems Engineering & Integration Branch

Thursday, 25 June, 0830-1000
COMPOSITE GROUP F SESSION .... Room I-122

Thursday, 25 June, 1030-1200
Conducting Practical Verification, Validation, and Accreditation (VV&A) in the Analysis of Alternatives
Mr. Keenan Kloeppel, Office of Aerospace Studies, Kirtland AFB

A New Commodity Price Forecasting Program for the Defense National Stockpile Center
Major Randy Zimmerman, DLA Office of Operations Research and Resource Analysis (DORRA)

Thursday, 25 June, 1330-1500
Analysis of Alternatives Using Optimal Weapon Allocation to Minimize Mission Costs
Mr. James LaMar, Northrop Grumman Corporation, Advanced Concepts Effectiveness Analysis

Commercial Best Practices and the DoD Acquisition Process
Dr. James S. B. Chew, Office of Naval Research

Alternate Papers

Identifying Performance Drivers for Theater Missile Defense
Barry L. Mitchell, Stephen E. Brown, and Thomas P. Spriesterbach, Johns Hopkins University Applied Physics Laboratory

Visualizing Courses of Action (COA) for Future Battlespaces
Mr. Michael J. Barnes, US Army Research Laboratory - Ft. Huachuca Field Element, Maj. Jerry L. Schlabach, Intelligence & Security Command, Dr. Jerzy Rozenblit, University of Arizona, and Col. Theodore Fichtl (ret), The Compass Foundation, Inc.

Description of the Weapon Optimization and Resource Requirements Model (WORRM)
Dr. Frederic A. Miercort, Institute for Defense Analyses

WG 26 -- ANALYSIS OF ALTERNATIVES -- Abstracts
Room: I-260

Tuesday, 23 June, 1030-1200
Measurement of Military Capability

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Measures of military capability are developed for inclusion in the Defense Program Projection. In particular, we offer measures of interdiction capability for air warfare and measures of deep strike capability for naval and land warfare. Thus far, measures of capability have been developed for interdiction and deep strike platforms and munitions.

Our approach to analysis considers platforms and munitions separately. In particular, the measures of the general capability of interdiction and deep strike platforms are stealth, precision, and accuracy. For munitions, the general measure of capability considered herein is expected kill potential. Summary capability measures are calculated as weighted averages of the inventories. Indicators or measures of stealth, laser-designating ability, sorties per day, expected kill potential, vertical launch system capacity, and range have been used to weight inventories of platforms and munitions. This analysis extends coverage of the non-fiscal impacts of resource allocation decisions tracked in the Defense Program Projection.

AoAs and COEAs: The Good, the Bad, and the Ugly

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This briefing presents examples of COEAs and AOAs, which illustrate both good and poor quality analyses. The briefing discusses the nature and uses of AoAs, presents principles for conducting robust and useful AoAs, and includes some suggestions for design and conduct of AoAs that would reduce the incidence of poor analyses.

Tuesday, 23 June 1330-1500
Army Analyses of Alternatives Framework

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In recent OSD senior level materiel acquisition decision meetings and AoA briefings, the OSD staff raised issues concerning the scenarios, threat, and Joint context for Army analyses. Issues raised include: threat levels and capabilities; Army tactical scenarios; impact of deep strike and operational level operations on tactical battles; timeframes for analysis; assumptions concerning other service capabilities; Army modernization plans; and alternatives addressing affordability (high/low mixes). As a result of these issues, the Army conducted a series of workshops to review the current AoA analysis procedures and methodologies; identify analysis elements that should be changed; and identify individuals responsible for developing new procedures. This briefing identifies the key issues discussed in the workshops that will shape the Army's future analysis framework for supporting requirements determination and materiel acquisition decisions.

Judging AoAs: Criteria for Producing Quality AoA Study Plans and Final Results

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The Air Force has implemented a new review process for AoAs that requires the study plan and study final results to be critically reviewed to ensure they meet acceptable standards for quality and consistency. The Office of Aerospace Studies has been given the responsibility for developing the AoA review standards and reporting the review results to the AFROC. Working with the Air Force analysis community, we have developed specific standards. A year's experience has shown that when study teams are given the standards, their products have shown a significant increase in quality. This paper addresses the detailed assessment criteria and lessons learned.

Wednesday,24 June, 0830-1000

UH-1N Helicopter Upgrade / Replacement Analysis of Alternatives

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The Air Force Space Command (AFSPC), Directorate of Requirements (DR), Force Applications Division (DRM) conducted an Analysis of Alternatives (AoA) to determine which procurement or leasing alternative to recommend for replacing the aging fleet of 64 UH-1N support helicopters. The AoA evaluated seven alternatives' ability to support the Air Force space wing security missions and to provide the mass passenger transportation in the National Capital Region. AFSPC/DRM performed the AoA in two phases. Phase I was completed the summer of 1997 and evaluated the UH-1N, UH-60L, and 4BN helicopters. Phase II is nearing completion and evaluated options for leasing helicopter support from civilian helicopter operators.

Analysts evaluated the performance and operational effectiveness of each of the alternatives against the requirements and mission profiles in the approved Operational Requirements Document. In addition, they researched and analyzed life cycle costs to compare the cost and cost-effectiveness of the alternatives. The presentation will describe the Mission-to-Task Hierarchy which linked the Measures of Performance (MOP) and Measures of effectiveness (MOE) to the mission profiles. It will also describe how analysts entered the process to calculate and compare the operational effectiveness of the alternatives. Finally, the presentation will describe the Automated Cost Estimating Integrated Tools (ACEIT)-based cost analysis methodology and results.

Carrier Air Wing Capabilities Assessment

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Dr. Robert Hubbard, Systems Analyst (CPF N645)
Mr. Adam Davidson, GS-13, Operations Research Analyst (CPF N643)
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In preparation for the FY 00 budget cycle, CINCPACFLT conducted a study to determine the most cost effective number and configuration of strike fighter aircraft within the Carrier Air Wing, given expected deck loading and fiscal constraints. This brief describes specifics of operational effectiveness modeling for multi-mission strike aircraft. Conducted under a compressed time-line, the study used Thor and CASES/ASBAT Monte Carlo simulations of strike fighter and support aircraft against realistic air defense threats. Attempts were made to capture the multi-mission capability of the F/A-18 E/F and F/A-18C as well as improvements in near-term air to ground ordnance. The study examined sortie generation capability and weapons effectiveness, the key factors in both offensive and defensive scenarios.

Wednesday, 24 June, 1030-1200

Airborne Mine Neutralization System Analysis of Alternatives

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To sustain the Navy's operation in the littoral and vital sea lanes of communication, Naval Forces must possess the ability to conduct mine countermeasures (MCM) to detect, localize, and neutralize the sea mine threat without impeding the speed of advance of the battle group. An Airborne Mine Neutralization System (AMNS) will provide future fleet helicopters with a rapid response MCM capability to neutralize mines in limited regions where mine avoidance is not expedient of possible safely and efficiently. An Analysis of Alternatives (AoA) was performed by the Navy to validate the operational need for AMNS and to independently assess the cost effectiveness of alternative approaches for expendable, naval helicopter delivered, remotely operated, mine neutralization devices (MND). General issues that were investigated include: What level of clearance is achievable within time periods defined for various operational settings? What is the relative cost and effectiveness of various design trades? What are the key cost drivers? What are the key performance and effectiveness measures (threshold and objective) that should guide the AMNS Program? What upgrades to AMNS would allow a "fire & forget" MND?

Quantitative Decision Support for Upgrading Complex Systems of Systems

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"System of systems" terminology is now widely used to describe how the successful, combined operation of many platforms, weapons systems, and communication systems is necessary to achieve an overall warfare objective, especially in joint operations. Although the characteristics and system engineering challenges associated with systems of systems are becoming well understood, effective architecting approaches that enable cost/performance trades are still immature.

A systematic approach to considering how best to upgrade specific, complex systems of systems is postulated and demonstrated. The process treats cost as the independent variable (CAIV) and seeks to find the "best" point design that may involve upgrading all component systems simultaneously, not just one at a time. The process has been demonstrated on a naval mine countermeasures (MCM) system of systems of sufficient complexity to demonstrate feasibility of the approach. The process formulates a constrained, nonlinear optimization problem whose objective function is a representation of the top-level measure of effectiveness (MOE), with constraints represented by functionalized Performance Based Cost Models, secondary MOEs, and technology-driven bounds on system measures of performance (MOPs). Both closed-form and simulation-based optimization approaches have been demonstrated and differences quantified, including the suboptimality of considering just one system at a time. A stochastic simulation of the MCM system of systems was implemented and optimized utilizing a constrained variant of the Simultaneous Perturbation Stochastic Approximation method, in order to demonstrate feasibility on complex systems of systems of national interest.

This process therefore demonstrates a disciplined, quantitative approach to developing system of systems upgrade options for very complex situations, which can result in more effective and comprehensive systems acquisition and technology investment strategies.

<u>*Wednesday, 24 June, 1330-1500*</u>
Alternatives for Enhancing Aircraft Survivability: An Application of Exploratory Analysis

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The purpose of this study is to examine various technical and operational means for enhancing aircraft survivability. In the first phase of this work, we use an exploratory analysis to determine options available to the strike force to achieve 90% survivability on a deep strike mission. Two surface to air (SAM) missile threat lay downs are considered: Operation Desert Storm with first generation SAMs (as a benchmark) and a future, 2006 scenario with second generation SAMs. Survivability enhancing options include low observability defined by parametric minimum signatures and signature shapes, Suppression of Enemy Air Defense (SEAD) packages to include Improved Tactical Air Launched Decoys (ITALOs), High speed Anti-Radiation Missile (HARM), and standoff jamming alone and in combination, and Electronic Counter-Measures (ECM) p_k degrades. Survivability is calculated using an integrated set of models that support SAM engagement analysis, threat avoidance routing, and mission-level analysis.

Typically, survivability analysis determines the survivability of a given set of options. In this study, we use exploratory analysis with large-scale computational experiments to determine the option mixes for a given survivability requirement. Methods for defining, controlling, and statistically analyzing the results are discussed.

The Necessity for Integrating Space Assets into Campaign Analysis

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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, &

analysis (MS&A) community must take a hard look at the design and implementation of the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Thursday, 25 June, 0830-1000

COMPOSITE GROUP F SESSION .... Room I-122

Thursday, 25 June, 1030-1200

Conducting Practical Verification, Validation, and Accreditation (VV&A) in the Analysis of Alternatives

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Air Force and DoD regulations require that VV&A is done on models and simulations (M&S) which are used to evaluate weapon system concepts. Because of tight budgets and shrinking staffs, innovative methods of conducting meaningful and cost effective VV&A need to be developed. The Office of Aerospace Studies (OAS) is integrating VV&A into the framework of the AoA process to take advantage of the AoA study teams that are already in place. By limiting the V&V effort to the problem being studied and distributing the effort among the M&S developers and AoA analysts, the V&V can be made relatively painless and accurate.

A New Commodity Price Forecasting Program for the Defense National Stockpile Center

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The Defense National Stockpile Center (DNSC) operates as an international commodity broker for more than 90 strategic and critical materials for the United States. The center, as a component of the Defense Logistics Agency (DLA), sold more than $391 million of excess raw or semi-processed materials in Fiscal Year 1996. DNSC is located at DLA Headquarters, fort Belvoir, Virginia.

The DNSC has traditionally relied on the trade press and the US Geological Survey (USGS) for much of the market information it evaluates. The Defense National Stockpile Center Commodity Analysis Program (S-CAP) was developed to complement existing DNSC-R staff analysis of commodity markets. The program evaluates three different forecasts, Naive forecast, double exponential smoothing using Holt's method, and a Variable Index Dynamic Average (VIDYA). It then chooses the forecast with the lowest overall error, calculates a market momentum over a user specified number of periods, and graphs the output.

The familiar forecasting techniques have been augmented by the use of VIDYA. This technique I a dynamic exponential moving average that adjusts its effective length using market variables and is responsive to market volatility. VIDYA can be indexed to the standard deviation of closing pries, a momentum oscillator, or to the coefficient of determination, r^2.

Significant potential benefits exist in applying this automated bid evaluation system to leverage increased revenue. Analysis of Lead (Pb) sales for October 1996-January 1997 demonstrated that this technique could have resulted in a net revenue increase of $1.1 million dollars to the government. This represents a potential 15.8% increase in sales revenue for the period.

Thursday, 25 June, 1330-1500

Analysis of Alternatives Using Optimal Weapon Allocation to Minimize Mission Costs

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In the development of affordable strike aircraft, mission and cost effectiveness are major drivers in the generation of requirements. The presentation/paper describes a linear programming methodology that provides the cost and operational effectiveness of alternative weapon system concepts, and the degree to which the alternatives are capable of meeting the system's mission objectives. This methodology minimizes the total mission cost by optimally allocating weapons based on weapon cost, attrition cost, and sortie operational costs. Weapon resources are filtered by mission constraints, delivery system parameters, and weapon resource parameters. Cost and performance results provide the measure of effectiveness to analyze the tradeoffs of the filtering constraints and parameters. An application of this method, as applied to a weapon bay sizing trade study, is presented.

Commercial Best Practices and the DoD Acquisition Process

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Continuous improvement continues to be the rallying point for Department of Defense (DoD) acquisition reform. The recent changes to DoD Instruction 5000 show that the department is streamlining the acquisition process to meet the realities of the evolving "new world" threats. As dramatic as the changes have been, there is room for improvement. Here we compare the streamlined DoD acquisition process with the process used in the American automobile industry, which continually deals with an ever-evolving threat. We discuss the Chrysler Corporation product development process and identify the "best process" in their product development system. These best practices can be applied to the DoD acquisition process.

ALTERNATE PAPERS

Identifying Performance Drivers for Theater Missile Defense

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Approved abstract unavailable at printing.

Visualizing Courses of Action (COA) for Future Battlespaces

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In the time-compressed battlefields of the future, using intelligent algorithms to assist commanders and their staffs will probably not only be an option but a necessity. Traditionally, there have been two main reasons that intelligent algorithms have failed to be a factor in the military domain: (1) their extreme brittleness in situation that cannot be modeled exactly, and (2) their opaqueness to the analyst or final decisionmaker. The use of modern computational methods has resulted in substantial progress in solving the brittleness problem, and the use of visualization technology offers the possibility of solving the second problem. We are in the process of combining a genetic algorithmic approach (FOX-GA (genetic algorithm)) developed at the University of Illinois with an object-oriented visualization environment (Advanced Battlefield Architecture for Tactical Information Selection (ABATIS)) developed through an Army Research Laboratory (ARL) research project at the University of Arizona. FOX-GA rapidly generates and evaluates thousands of courses of action for maneuver environments. Using a niching strategy, the algorithm can choose a set of "best" solutions with distinctly different characteristics. ABATIS has been used by ARL and the University of Arizona researchers to display and evaluate various two- and three-dimensional military visualization concepts. The chief advantages of ABATIS are its ability to develop new visualizations rapidly and its amenability to simulation experimentation.

Our initial step will be to combine FOX-GA with animated visualization packages designed to depict the chosen subject of optimal solutions using the genetic algorithm's fitness function as its input. Force ratios and terrain parameters will be displayed as well as a three-dimensional representation portraying the battle progress of enemy and friendly forces. Menus will be designed to allow the user to evaluate additional alternatives. Early versions of the visualizations will be abstract; however, sophisticated three-dimensional terrain visualization packages will be added eventually to permit thorough terrain analysis for each option. At every stage of the project, we will use experts from Ft. Huachuca to guide our efforts. The evaluations will include formal assessments, soldier-in-the-loop experiments, and validations during realistic simulations or field exercises.

Description of the Weapon Optimization and Resource Requirements Model (WORRM)

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WG 27 – COST ANALYSIS – Agenda

Chair: Dr. Bruce MacDonald, MCA Research
Cochair: Mr. Stephen E. Myers, Applied Physics Laboratory, Johns Hopkins University
Advisor: LCDR Timothy P. Anderson, Naval Postgraduate School
Room: R-242

Tuesday, 1030 - 1200
PANEL DISCUSSION: TOTAL OWNERSHIP COSTS
Jack Graser (Session Chair), The RAND Corporation; Robert Young, US Army Cost & Economic Analysis Center; Col Ed Weeks, Assoc. Deputy Assistant Secretary of the Air Force (Cost & Economics); John S. Smuck, Naval Center for Cost Analysis

Tuesday, 1330-1500
PANEL DISCUSSION: NEW RESEARCH FINDINGS IN MODELING COST/SCHEDULE RISK
Dr. Paul R. Garvey, (Session Chair), The MITRE Corporation; DR Stephen A Book, The Aerospace Corporation; Morteza Anvari, US Army Cost & Economic Analysis Center

Wednesday, 0830-1000 The Role of Cost Analysis in Acquisition Reform
Cost As An Independent Variable (CAIV) Implementation
Henry Apgar, MCR Federal, Inc.

The Role of Cost Estimation in Acquisition Decision Making
Gary Paull, MCR Federal, Inc.

The Use of Parametrics in Today's Analysis Environment
Neil Albert (Session Chair), MCR Federal, Inc.

Wednesday, 1030-1200
Economic Analysis of the Integrated Condition Assessment System
Pete Kusek, Center for Naval Analyses

The Navy Cost of Manpower Estimating Tool (COMET) Overview
Kimberly L. Darling, SAG Corporation

When Does Collocation Save Money?
Dan Levine, Institute for Defense Analysis

A Decision Support Framework for Risk, Confidence and Cost Tradeoffs in Operational Test and Evaluation
Dr. Frank B. Gray and Major Suzanne M. Beers, Air Force Operational Test and Evaluation Center

Wednesday, 1330-1500
PANEL DISCUSSION: ECONOMIC CONSIDERATIONS IN DOD PRIVATIZATION EFFORTS
Walter J. Hosey (Session Chair), Director of Economics and Business Management, Department of the Air Force; Lt Col Steve G. Green, US Air Force; Lt Col Michael J. Meese, US Military Academy; Dave Wennergren, Head, Regionalization, Plans and Policy Branch OPNAV (N 46E), Pentagon

Thursday, 0830-1000
COMPOSITE GROUP F SESSION .... Room I-122

Thursday, 1030-1200 Statistics, Econometrics and Cost Analysis
Aircraft O&S Cost Estimating Relations Using Cross Section and Time Series Data
Gregory G. Hildebrandt (Session Chair), Manbing Sze, Naval Postgraduate School

The Minimum-Unbiased-Percentage Error Method (MUPE) for Least Square Regressions in Cost Analysis
Dr. Shu-Ping Hu, Tecolote Research, Inc.

Hazardous Materials Impact Assessment For Environmental Life Cycle Cost Analysis
William H. Jago, Tecolote Research, Inc.

From Lanchester Models to Cost Analysis
Col Raymond E. Franck, Jr., USAF Academy, CO 80840; Gregory G. Hildebrandt, Naval Postgraduate School

WG 27 – COST ANALYSIS – Abstracts
Room: R-242

Tuesday, 1030 - 1200
PANEL DISCUSSION: TOTAL OWNERSHIP COSTS

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In 1995, the USD(A&T) established total life-cycle cost (LCC) as equal to performance with the promulgation of a "Cost as an Independent Variable" (CAIV) policy. Department efforts to fully implement CAIV have been hampered by limited visibili8ty into true ownership costs. In 1995, DoD was relying on the Visibility and Management of Operating and Support Costs (VAMOSC) systems of each Service to provide cost insight. However, Services' differences in implementation and lack of process costs have limited the applicability of VAMOSC data on a department-wide basis. To fully implement CAIV and to assist in reducing near term operating and support (O&S) costs, process and product costs must be available and visible.

In addition to the focus on CAIV implementation, one of the DoD Acquisition Year 2000 National Performance Review Goals is to:

> "Define requirements and establish an implementation plan for a cost accounting system that provides routine visibility into weapon system life cycle costs through activity based costing and management. The system must deliver timely, integrated data for management purposes to: permit understanding of total weapon system costs; provide a basis for estimating costs of future systems; and feed other tools for life cycle cost management."

Each of the three Service presenters will provide the latest information on current and planned actions underway to provide better insight into TOC. Each panel member will brief for 20 minutes, with 15 minutes for questions at the end.

Tuesday, 1330-1500
PANEL DISCUSSION: NEW RESEARCH FINDINGS IN MODELING COST/SCHEDULE RISK

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This panel discussion will concentrate on the latest innovations in capturing cost and schedule uncertainties for program cost estimates. This includes the use of commercial modeling and simulation tools. In addition, the panel will address issues and considerations associated with: How *the revised DOD 5000 series affects how cost/schedule risk is addressed. Capturing correlation in cost/schedule risk analysis – does it matter? Processes, analysis tools, and procedures used to quantify cost/schedule risk. What the military departments are doing to train their cost analysts in this important area of cost analysis.*

Each member of the panel will give their perspectives on one or more of these topics. This will be followed by an open discussion between panelists and the audience.

Wednesday, 0830-1000 The Role of Cost Analysis in Acquisition Reform
Cost As An Independent Variable (CAIV) Implementation

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The Role of Cost Estimation in Acquisition Decision Making

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Cost estimation is an essential component of the acquisition decision making process. The role of cost estimation and the associated methodologies vary depending on the phase of the decision making process. This discussion outlines the acquisition decision making process as implemented by the Federal Aviation Administration (FAA) and highlights the integral nature of cost estimation to making successful investment decisions.

In April of 1996, the FAA Acquisition Management System (AMS) was introduced. The goal of the AMS is to facilitate informed, integrated decision making which results in more timely and cost effective acquisitions. In the initial stages of the acquisition decision making process, cost estimates are needed to provide rough order of magnitude (ROM) funding level requirements. Cost ranges are typically estimated to reflect the various technical solutions available and to provide the decision-maker with an early outlook on funding needs. As the system operational requirements and potential solutions become better defined, the cost estimate incorporates more specific inputs. Viable alternatives are analyzed and compared using both traditional cost benefit analysis and qualitative criteria. Confidence intervals are developed to reflect both the uncertainty and risk surrounding cost, schedule, and technical parameters. Affordability assessments are conducted to identify how the program can best meet overall agency budget constraints. The acquisition decision making process culminates in an approved baseline for the costs, benefits, schedule, and technical performance of a preferred alternative.

The Use of Parametrics in Today's Analysis Environment

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<u>Wednesday, 1030-1200</u>
Economic Analysis of the Integrated Condition Assessment System

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The US Navy is pursuing administrative and technological innovations to limit the amount of work required aboard ships in order to reduce crew sizes. The Integrated Condition Assessment System (ICAS) is one of the technological innovations. ICAS collects real time operating data on ship propulsion and auxiliary systems and allows onboard technicians to compare such data with established engineering performance data. Among other benefits, this helps the technicians to avoid unnecessary maintenance, anticipate equipment failures, and take early corrective action.

Although the benefits of ICAS seemed evident, no one had conducted a systematic analysis to calculate how the costs and benefits compared. Hence the reason for this economic analysis in which we estimated the 20-year life cycle costs and benefits of ICAS on six different ship classes. We included not only the initial purchase, installation and annual operating costs of ICAS but also the periodic costs of replacing ICAS components as they reached the ends of their economic lives. Benefits included reduced ship crews, a need for fewer repair parts, better fuel economy, and reduced depot maintenance costs.

We found that the payback period for ICAS was excellent on five of the six ship classes examined and that total savings to the US Navy could reach almost $35M per year for just those five ship classes. In short, ICAS is a good investment for the US Navy.

The Navy Cost of Manpower Estimating Tool (COMET) Overview

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The Navy Cost of Manpower Estimating Tool (COMET) was developed to enable defense contractors and Navy cost analysts to accurately and consistently estimate personnel-related costs associated with a system, platform or any other type of billet structure. COMET is the product of two separate initiatives: the Billet Cost Factor (BCF) Model and the Cost of a Sailor (COAS) Study. During the past five years, N-81 has sponsored the development of the BCF system, which was a DOS-based application that provided detailed, skill and paygrade-level manpower costs. Over the past year, SAG and NCCA have worked together to combine the BCF model and the COAS study. The result is

COMET, a Windows95-based model.

COMET provides estimates of both direct and indirect costs. Each sailor or officer assigned to a billet generates easily identifiable direct costs (the majority of which are pay and allowances). Indirect costs, however, are equally as important. This category includes costs associated with recruiting, training and providing medical care to military personnel. Both types of costs are captured in COMET. The algorithms that underlie the computer model spread these costs over paygrade and skill specific billets. The model calculates life cycle costs and implicitly addresses challenging issues regarding how to amortize certain "investment" costs over the career of a billet. This presentation will provide an overview of the underlying methodology and a brief demonstration of the model.

When Does Collocation Save Money?

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A Decision Support Framework for Risk, Confidence and Cost Tradeoffs in Operational Test and Evaluation

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A framework is presented to help decision-makers select and modify operational test designs based on risk, confidence and cost tradeoffs. In the setting defined here, risk is measured in terms of the expected gain from a test event. Gain can be realized by finding a system deficiency during testing (so that it can be corrected before use in combat) or by increasing the precision of an estimated performance parameter. Confidence is applied subjectively to summarize decision-makers' beliefs in how well each alternative test approach will capture the effects of operational conditions on test item performance. Risk is assumed to decrease as gain increases, while confidence can be increased by larger investments in test infrastructure. The effect of higher confidence is modeled as a larger marginal gain from each test event. A classic marginal analysis is then performed to compare the expected marginal gain from an additional test event to the expected marginal cost. Graphical outputs from this marginal analysis provide concise displays of tradeoffs and allow a decision to select good test strategies. The entire framework is illustrated with an example pertaining to testing an aircraft self-protection jammer.

Wednesday, 1330-1500

PANEL DISCUSSION: ECONOMIC CONSIDERATIONS IN DOD PRIVATIZATION EFFORTS

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As the Department of Defense continues to reduce combat forces, due in part to budgetary constraints, there is relentless pressure to carefully examine how the Department is spending its non-combat budget. Over the past few years, the conventional wisdom is that we will "outsource and privatize" those activities that are not in direct support of combat (and which have commercial sector capability). By doing so, the logic follows, we will save large amounts of budget dollars that can then be used to modernize our aging weapons systems.

The intuitive appeal of this argument is very attractive. However, we must ask ourselves whether our actual experience is consistent with the cost savings envisioned. Will we really save money by privatization? Other questions are equally important. What are the near and long term impacts on the defense industrial base as we relinquish organic capability? How will readiness and the ability to deploy forces, particularly for extended periods, be impacted? Are there episodes in our military history in which privatization was attempted – what were the results? As the DOD, whose budget is viewed as "discretionary" from a macro governmental perspective, turns to privatization, what are the consequences of the attendant "must pay" contracts on budget flexibility? The answers to these and many other questions are fundamental to informed DOD privatization decisions.

This session will provide a forum for those most closely associated with the privatization of DOD activities to share experiences ... both success stories and mistakes made. The intended result is a more informed cadre to advise senior DOD decision-makers of the potential benefits and accompanying risks of privatization.

Thursday, 0830-1000

COMPOSITE GROUP F SESSION .... Room I-122

Thursday, 1030-1200 Statistics, Econometrics and Cost Analysis

Aircraft O&S Cost Estimating Relations Using Cross Section and Time Series Data

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The military services collect operating and support (O&S) cost data using the Visibility and Management of Operating and Support Cost (VAMOSC) database. For the Air Force, yearly data grouped by each mission design series (MDS) aircraft have been used to develop cost estimating relationships that explain O&S cost as a function of aircraft characteristics and operating tempo. Aircraft characteristics may include flyaway cost, aircraft type, design age, and year of initial operational capability. Optempo has been measured using flying hours per aircraft.

Because both grouped cross section and time series data are included in VAMOSC, the error term of a cost estimating relationship obtained using ordinary least squares (OLS) may be both non-constant (heteroscedastic) and serially correlated. While these violations of the linear regression model do not yield biased estimates of the parameters of the cost estimating relationship, the estimates obtained would be inefficient and the significance tests misleading. A generalized least squares (GLS) procedure is employed to address the problems with the error term. This procedure permits the entire aircraft VAMOSC database to be employed in the estimation process, and has applicability to many cost estimation problems when large data sets combining cross section and time series data are used.

The Minimum-Unbiased-Percentage Error Method (MUPE) for Least Square Regressions in Cost Analysis

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Regression equations to provide unbiased predictions are always worth pursuing. A Minimum-Unbiased-Percentage Error (MUPE) technique has been developed to model the multiplicative error in least-squares regression. Multiplicative error is an appropriate assumption when modeling data where the dependent variable ranges over more than an order of magnitude and errors in the dependent variable are believed to be proportional to the level of the variable. Previous methods to model multiplicative error have usually depended on log-transforms or the weighted least-squares equations (i.e., to weight the residual by the reciprocal of each observation). Unfortunately, none of these methods produce unbiased equations in unit space.

MUPE involves an iterative, weighted least squares regression that is shown to provide unbiased percentage error regression results while modeling a multiplicative error. No transformation or adjustment (to correct the bias in the unit space) is needed to fit a MUPE CER. Goodness-of-fit measures (or asymptotic goodness-of-fit measures) can be applied to judge the quality of the model under the normality assumption. Recently, Tecolote Research has incorporated MUPE into its CO$TAT statistical package and tested it using databases for the Unmanned Space Vehicle Cost Model, Seventh Edition (USCM7). (USCM7 provides CERs for estimating the cost of earth-orbiting, unmanned space vehicle programs at both the component and subsystem levels.) Analyses of real examples comparing four different methods (dealing with multiplicative errors) are provided in this paper. The four methods include MUPE, MPE (Minimum-Percentage Error), Log-Errors, and constrained Excel Solver solution. A few traditional and heuristic predictive measures for non-linear equations are also discussed.

Hazardous Materials Impact Assessment For Environmental Life Cycle Cost Analysis

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Systems drive the use and generation of toxic and hazardous substances throughout their life cycle phases, from production through disposal. The analysis of the environmental, safety, and health (ESH) cost drivers must go beyond just tabulating media quantities to also include the hazard impacts of priority substances, which drive organizational response. The correlation of environmental costs with media quantities should be improved by applying hazard impact scores of priority substances as a cost driver. The purpose of this paper is to summarize the hazard impact analysis methodology in the Environmental Costs of Hazardous Operations (ECHO) model recently developed under a SBIR Phase II contract to NAWC, Aircraft Division.

The parameters used to develop hazardous impact scores consist of regulatory and chemical characteristic data. Regulatory data are classifications, thresholds, and prioritization lists which invoke compliance activities and motivate pollution prevention efforts. Characteristic data are toxicity and physical property data used as criteria in developing regulations. Chemical hazard impact scores are developed using a normalization procedure that fits parameter data to regulatory thresholds using beta distribution CDFs. The normalization process reduces

parameters of the same type to a common basis to allow the selection of the strictest criteria within an impact category. The data is also organized into regulatory and chemical impact hierarchies so that weighing factors may be developed to rank the impact categories using AHP. Material hazard scores are developed as the weighted average of their constituent chemicals hazard scores. The V-22 Osprey was used in an ECHO case study.

From Lanchester Models to Cost Analysis

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The modeling of military effectiveness has frequently built up the framework developed by Lanchester. For example, this framework has been extended to address trade-offs between quantity and quality so that one can evaluate, say, alternative combinations of individual aircraft performance and the numbers of aircraft that yield the same level of military capability. Cost estimating relationships have also been developed which estimate the cost of aircraft as a function of both performance and quantities. These cost relationships can be used to analyze alternative combinations of aircraft performance and aircraft quantities that yield the same level of total cost.

The connection between the constant effectiveness trade-off curves and the constant cost curves is an essential component of the analysis of alternatives. Using a cost-estimating relationship developed for tactical aircraft by the authors and Lanchester models of aircraft effectiveness, we integrate the cost and effectiveness analytical frameworks. Complications occur because technical progress shifts the cost relationship over time, and changes in the threat shift the effectiveness relationship. In the language of economics, the former is similar to a shift in the supply curve and the latter is similar to a shift in the demand curve. We describe the information requirements needed to properly analyze alternatives when such dynamic changes occur, and illustrate methods of dealing with these changes using various cost and effectiveness models for tactical aircraft.

Thursday, 1330-1500
The Response of Aviation Training Costs to Changes in the Requirement for Aviators

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This presentation describes an analysis that sought to answer the following question: What is the change in the annual costs of undergraduate naval aviation training associated with a unit change in the requirement for operational aviators? The analysis used the historical Future Years Defense Program (FYDP) as its primary database. No cost distinction was made among training of strike pilots, maritime pilots, rotary pilots, and navigators/naval flight officers. The number of operational aviators reported in the FYDP constituted the determinant of the contemporaneous level of aviator training activity. (There was no statistical evidence of lags in the relationship.) The study accounted for the joint occurrence of Navy and Marine Corps aviator training in its results. The final estimate, $72 thousand in fiscal 1997 prices, included both military personnel and operation and maintenance components. No attempt was made to include procurement costs in the estimate. These results have been incorporated into the Navy's Cost of Manpower Tools (COMET) information system.

UH-1N Helicopter Upgrade/Replacement Analysis of Alternatives

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The Air Force Space Command (AFSPC), Directorate of Requirements (DR), Force Applications Division (DRM) conducted an Analysis of Alternatives (AoA) to determine which procurement or leasing alternative to recommend for replacing the aging fleet of 64 UH-1N support helicopters. The AoA evaluated seven alternatives' ability to support the Air Force space wing security missions and to provide mass

passenger transportation in the National Capital Region. AFSPC/DRM performed the AoA in two phases. Phase I was completed the summer of 1997 and evaluated the UH-1N, UH-60L and 4BN helicopters. Phase II is nearing completion and evaluated options for leasing helicopter support from civilian helicopter operators. Analysts evaluated the performance and operational effectiveness of each of the alternatives against the requirements and mission profiles in the approved Operational Requirements Document. In addition, they researched and analyzed life cycle costs to compare the cost and cost-effectiveness of the alternatives. The presentation will describe the Mission-to-Task Hierarchy, which linked the Measures of Performance (MOP) and Measures of Effectiveness (MOE), to the mission profiles. It will also describe how analysts entered the hierarchy, performance analysis results, and operator opinions into an Analytic Hierarchy Process to calculate and compare the operational effectiveness of the alternatives. Finally, the presentation will describe the Automated Cost Estimating integrated Tools (ACEIT)-based cost analysis methodology and results.

The US Aircraft Carrier Industrial Base: Labor Model of Newport News Shipbuilding

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RAND has recently completed a detailed study of the U.S. aircraft carrier industrial base, focusing on the force structure, cost, schedule and technology issues associated with CVN 77, the last *Nimitz* carrier. A critical part of the research was the development and use of a linear programming model of the labor force at Newport News Shipbuilding. The model considers all new construction and overhaul projects scheduled for the yard and determines the total demand for labor in nine different skill groups over time. The model minimizes the total costs associated with building up and bringing down the workforce to meet the anticipated demands for labor. The model constrains the workforce expansion based on the availability of labor in the marketplace, the training requirements associated with different skill groups, and the mentoring rules that exist between skilled and unskilled labor. The model also allows overtime and outsourcing to meet temporary peak demands for specific skills.

The briefing will discuss the construction and use of the model and how the results of the overall study were instrumental in determining a cost effective build schedule for CVN 77. The research results were presented in a testimony before the Senate Seapower Subcommittee and widely briefed throughout the Congress, the OSD and the Navy.

Defense Logistics Services Center Customer Service Call Center Project Economic Analysis

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Government agencies have been tasked by National Performance Review initiatives to improve service levels and put their customers first. Executive Order 12862 called on government agencies to establish customer service standards in accordance with the best practices in both business and government and to strive to achieve those standards.

In order to improve service to customers, Defense Logistics Agency Materiel Management (DLA-MM) tasked the Defense Logistics Services Center (DLSC) to manage the agency's telephone service improvement program. As part of this initiative, DLSC proposed the collocation and integration of its call center operations with those of the Defense Reutilization and Marketing Service (DRMS) and the Air Force Cataloging and Standardization Center (CASC) is scheduled to be incorporated into DLA.

The purpose of this study was to conduct an economic analysis in order to assist DLSC in the assessment of the costs and potential benefits of the proposed Integrated Call Center Project. Cost and operational comparisons to other DoD call centers were developed. Overall, the analysis indicated that DLSC has implemented a program which will provide superior customer service at reduced cost and measurable quantitative benefits to its customers in the form of faster, more efficient service. This improved efficiency will translate into labor and associated cost savings for DLSC, DRMS and CASD customers.

WG 28 – DECISION ANALYSIS – Agenda

Chair: LtCol Jack M. Kloeber, Jr., AFIT
Co-chair: LTC Dan Maxwell, USArmy CAA
Co-chair: LtCol Jack A. Jackson, AFIT
Co-chair: Maj David Taylor, USAR
Advisor: Dr. Gregory Parnell, FS, Virginia Commonwealth University
Room: I-119

1030-1200, Tuesday, June 23rd
Building and Using a Value Model to Support Global Positioning System (GPS) Modernization
Lee J. Lehmkuhl, David J. Lucia, and James K. Feldman

Designing a Long Term Space Systems Architecture Through Optimization, Angela Giddings
Victor Wiley, Michael Lewis, Timothy Gooley, and Don Olynick

Communications Value Model
Steve Sovaiko and Dr. Gregory Parnell

Session 2: 1330-1500, Tuesday, June 23rd
Joint Session with WG 8 .... Room I-122

Learning Bayesian Networks for Intelligence Applications
Dennis Buede and Terry Bresnick

Value Driven Measures of Merit for Offensive Information Operations
Michael P. Doyle, Richard F. Deckro, Jack A. Jackson, and Jack M. Kloeber

Allocating the Threat
Peter C. Byrne, Richard E. Rosenthal, and Brian Widdowson

Session 3: 0830-1000, Wednesday, June 24th
Revolutions in Military Affairs, New Measures of Effectiveness, and Good Old Fundamental Objectives
Dan Maxwell

The Necessity for Integrating Space Assets into Campaign Analysis
James R. Hunter and Mark A. Powers

Reengineering the Wheel: Integrating System and Process Development
Kenneth E. Kaizer

Session 4: 1030-1200, Wednesday, June 24th
Using multi-objective decision analysis to select Air Force communications and information work centers for A76 study
Mr. David M. Hickman

Decision Analysis for the Privatization of the Cleanup of the Hanford Nuclear Reservation Radioactive Tank Waste
W. A. (Andy) Hesser, Mark A. Robershotte, and Peter McLaughlin

Using multiple attribute utility theory to select production units for elimination or retention and expert system approaches to weight value functions and validate unit selection algorithm output
Mr. David M. Hickman

Session 5: 1330-1500, Wednesday, June 24th
Determining the Optimal Mix of Military Family Housing for the Monterey Bay Military Housing Project
David M. Shade, Gerald M. Pearman, John F. Raffensperger, and Keeboom Kang

A VFT Approach to Allocation of Manpower and Budget Cuts
Tom Boushell, Jack M. Kloeber Jr., and James T. Moore

Air Staff Allocation of Military Family Housing Investment Funds
Tim Imdieke and Jack M. Kloeber Jr.

Thursday, 0830 - 1000
COMPOSITE GROUP F SESSION .... Room I-122

Session 6: 1030-1200, Thursday, June 25th
Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP) Requirements Analysis
Mr. Patrick G. Smock and Maj John M. Harwig

An Analytical Tool to Assess Aeromedical Evacuation Systems for the DoD
Scott Wilhelm and Jack A. Jackson

F/A-18F Aft Crew Vehicle Interface (CVI) Enhancement Using Quality Function Deployment (QFD)
Daniel D. Dassow

Optimizing the Integration of Modeling and Simulation into the Test and Evaluation Process
Dr. Henry Dubin, Dr. Cyrus Staniec, and Lambert Sebastiani

Session 7: 1330-1500, Thursday, June 25th
Facilitation Skills as Part of an Analysts Toolset
Stephen R. Hyde and Diane B. Affleck

Implementing an Investment Strategy Process for CVX
John E. Christian and Earl W. Hacker

Distributed Decision Support
Stephen R. Hyde and Diane B. Affleck

WG 28 – DECISION ANALYSIS – Abstracts
Room: I-119

Title: Building and Using a Value Model to Support Global Positioning System (GPS) Modernization

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The Global Positioning System (GPS) is a constellation of satellites which provides position, velocity, and timing (PVT) information to civilian and military users worldwide. The United States government is planning to field the next generation of GPS, and there are several competing architectures that differ significantly in terms of cost and capability. The analysis presented here uses Value Focused Thinking (VFT) to determine the relative value to senior leaders of functions and tasks supported by GPS, in terms of numerical weights. VFT then quantifies the contribution of each alternative architecture to these functions and tasks. This presentation focuses on three facets of the analysis. First, we discuss the development of the value model, which began with requirements documents and involved the GPS community in a vetting process. Second, we show how preliminary sensitivity analysis can lead to aggregate weights and scoring functions. Aggregate weights indicate the relative importance of basic performance measures across functional areas. Aggregate scoring functions reveal the changes in the cumulative marginal value of basic performance measures across functional areas. Third, we use the value model to score several draft GPS architectures. The scores along with the earlier sensitivity analysis indicate that better alternatives may be required to adequately address user values revealed in the value model.

Designing a Long Term Space Systems Architecture Through Optimization

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Decision analysis, cost analysis, and mixed integer programming are combined in the Space and Missile Optimization Analysis (SAMOA) to identify possible 25-year acquisition plans for AF Space Command (AFSPC) assets. In FY97 SAMOA used the analytical hierarchy process to assess how well future AFSPC concepts might address identified deficiencies and how important each deficiency was to mission performance. The mixed integer program in SAMOA selected concepts to activate and specified their start and end years in order to maximize deficiency coverage subject to the given annual budget limits and launch vehicle supply and demand relations. The FY97 SAMOA effort provided AFSPC with their first cost-constrained look at their long-range acquisition strategy – identifying the impact of unfunded programs. Final FY97 SAMOA results will be presented along with a discussion of FY98 SAMOA improvements and preliminary FY98 results.

Communications Value Model

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A major shortcoming in current defense communications architecture acquisition is the lack of credible methods to assess the operational value of the various architecture alternatives. Modern communication systems are procured on the basis of how well they meet system performance criteria, but little is understood about how the individual systems increase the operational value of the entire defense communications architecture. This paper applies the Decision Analysis technique of Value-Focused Thinking (VFT) to develop a methodology to assess the operational value of communications architectures. The research employs VFT to develop a value model linking the tasks and attributes of communications systems with operational value, then demonstrates the ability of the model to compare competing communication acquisition alternatives by exercising the model in a hypothetical architecture decision example. The Communications Value model is useful for assessing operational value of the current defense architecture baseline and its competing acquisition alternatives, and also to generate additional alternatives that enhance or increase overall communications architecture operational value.

Learning Bayesian Networks for Intelligence Applications

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Value Driven Measures of Merit for Offensive Information Operations

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Measures of merit for offensive information operations (IO) are developed and applied to campaign-level and acquisition support scenarios. Value-focused thinking and multiobjective value analysis are employed to develop these measures of merit based on the values and preferences of owning decision makers. Courses of action are developed as part of demonstrating campaign-level planning, and are scored, evaluated, and ranked. Similarly, the IO weapon systems used in the acquisition scenario are scored, evaluated, and ranked. The sensitivity of the resultant alternative ranking is evaluated and its importance identified. This methodology is also used to characterize each alternative course of action and weapon system as to its ability to fulfill the owning decision maker's objectives. Finally, these characteristics are used to develop new and better alternatives for each decision opportunity.

Allocating the Threat

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The Capabilities Based Munitions Requirements (CBMR) process as defined in DODI 3000.4, 16 July 1997, requires that the Threat as defined in the DIA "Outyear Threat Report" be allocated among the services and allies for each Major Theater of War (MTW) defined as an Illustrative Planning Scenario in the Defense Planning Guidance.

We have developed the Phased Threat Distribution (PTD) model to accomplish the allocation. PTD is a multi-period goal program (using elastic variables). The periods are user defined but normally conform to those of the Illustrative Planning Scenarios. The model provides for phased platform reinforcement and munition expenditure and resupply. It includes not only air-to-ground but also ground-to-ground engagements. Time indexing in an engagement mapping set (that defines logical and allowable platform-target pairs) captures some of the maneuver dynamics of a "warfight." The engagement set is a PTD mechanism that orchestrates the optimization such that it is logical and consistent with the MTW's OPLAN/CONPLAN.

PTD currently allocates threat in terms of numbers and percentages of opposing weapons systems among the Services and Allies. We present emerging results and compare the model-generated outcomes with those independently produced by the CINCs. Future development will provide a capability to produce cost-based trade-off analyses among alternative munitions mixes.

Revolutions in Military Affairs, New Measures of Effectiveness, and Good Old Fundamental Objectives

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Joint Vision 2010 prescribes a doctrine that capitalizes on emerging military and information technologies. The systems and doctrine are proven. Simulations and experiments have provided the requisite evidence; the long-awaited revolution in military affairs (RMA) has arrived.

The military operations research community has been a key part of the RMA. We have been the purveyors of quantitative evidence of the increasing efficiency of America's military. Given the RMA, we now seek new measures of effectiveness (MOE) that will help us to better demonstrate potential contributions of the new systems and doctrine. The hypothesis is accepted; the RMA is a robust replacement to existing capabilities and doctrine.

Dan postulates the existence of an enduring set of fundamental objectives that military analysts can apply as a foundation for their analysis in the future. These objectives are reflective of the essential reasons that national leaders are interested in military effectiveness. A chain of reasoning is then offered that connects these fundamental objectives to the tasks that are performed by military forces. The reasoning also connects the objectives to the doctrine and systems that are being developed to accomplish those tasks.

The talk concludes with some thoughts on how the military analysis community could apply this paradigm to better support defense leaders.

The Necessity for Integrating Space Assets into Campaign Analysis

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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, & analysis (MS&A) community must take a hard look at the design and implementation of the current and future

underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Reengineering the Wheel: Integrating System and Process Development

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The future of military decision making and system development will be one of concurrency and integration. Doctrine and personnel changes can no longer lag behind technology development. With commercial technology existing in life cycles of eighteen to twelve months, the economic factors alone dictate a change in process. Yet, the compelling factor of involving decision makers in the system development process, may be more important. Having the right system for the operation, and the proper personnel to do the job is not a luxury, it is a necessity.

This presentation will deal with the four components which must be dealt with to produce the suitable environment for a successful future. The components are: (1) creating an understanding of the dependencies which exist between technology, doctrine, and personnel when a change is instituted or new development is initiated in any of the three. (2) Taking a fresh look at how the processes of Decision Making, Logistics, Operations Management, and ISR not only will work together, but how they will interrelate in the future to allow for simultaneous planning. (3) Continuing the discussion of the information matrix; its structure, function, and utility as an integrated environment. (4) Finally, I'll propose how we can use dynamic models to pull these components together in a tool that developers and decision makers can use concurrently to develop architectures which integrate technologies , doctrine, and personnel providing a low cost and effective way of implementing the new systems and processes.

Using multi-objective decision analysis to select Air Force communications and information work centers for A76 study

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Study purpose is to rank order work centers by likely utility of outsourcing and privatization.

The Air Force has a significant bill to pay for modernization. It has elected to generate modernization funds through outsourcing a large number (40,000) of positions. Air Combat Command must identify at least 3,000 of its 14,000 communications and information positions for participation in an A76 Outsourcing and Privatization Study.

The problem with selecting work centers for outsourcing and privatization is the vast number of work centers (4,000) and contained positions (14,000). There were no consistent decision rules applied in early submissions. This caused inequity in the numbers and types of work centers and positions initially identified. Further problems became apparent when types of positions were not treated consistently across Air Combat Command.

This study uses multi-objective decision analysis to identify positions eligible for outsourcing and privatization. A standard algorithm and set of decision rules is applied across 14,000 positions in 800 units at 150 locations. The result is a consistent, defensible, equitable, and militarily sound selection of work centers for study for outsourcing and privatization.

Decision Analysis for the Privatization of the Cleanup of the Hanford Nuclear Reservation Radioactive Tank Waste

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Complex environmental clean up problems are fertile ground for decision analysis applications. Both DOD and DOE are considering privatization approaches in procurements for addressing these environmental legacy problems. The privatization of the clean up of the highly radioactive and toxic tank wastes at the DOE's Hanford Nuclear reservation in Washington State poses one such extremely complex decision environment fraught with uncertainty and multiple competing objectives. The application detailed in this paper discusses the integration of decision analysis into a larger more complex analysis. Tools employed include contractual risk allocation and value focused thinking for incorporating stakeholder values. Besides some traditional comparison of alternatives against criteria, it also considers the larger questions of best value to the government - a concept that will be increasingly important as budgets get tighter.

Using multiple attribute utility theory to select production units for elimination or retention and expert system approaches to weight value functions and validate unit selection algorithm output

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The Air Force is currently considering streamlining its officer production system. A large part of the infrastructure is invested in Air Force ROTC. Past efforts at streamlining have met with resistance at the Air Staff and congressional levels. The Army has been more successful at reducing the size of its ROTC program. This paper will examine the Army's methodology, its validity, and the reasons for their success.

The United States Army Cadet Command is the Army's Reserve Officer Training Corps. Cadet Command has been downsizing headquarters and eliminating army ROTC units since the late 1980's. A variety of algorithms have been used to select headquarters and units for elimination. The effectiveness and complexity of these methods have changed over the last eight years. The most recent iteration of downsizing serves as an excellent example for the benefit of using both multi-attribute utility theory and expert system approaches to select units for elimination and get approval through Congress despite a clear reluctance to close units in any constituency.

Determining the Optimal Mix of Military Family Housing for the Monterey Bay Military Housing Project

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As part of DoD's housing privatization effort the Defense Language Institute (DLI) at the Presidio of Monterey decided to privatize over 1500 family housing units at the former Fort Ord. The primary objective of this study was to maximize DoD's utility by identifying the optimal mix of housing types on some parcels of land, while selling other parcels of land. TRAC-Monterey developed a model to determine the optimal mix of housing units for each parcel of available land, given some data on the military housing population, future military housing requirements, assets available, and command utility.

TRAC developed a function describing DoD's utility for the possible service family housing assignments. DLI specified a desired level of service (percentage of population accommodated) and a desired protection level against a housing shortfall (stockout). The decision variables included: parcel(s) of land to buy, parcel(s) of land to sell, and the number of housing units (of each type) to construct on each parcel of land. Constraints included cost, land and water resources, and minimum housing requirements.

Other project objectives included: identifying the water surplus, estimating the current value of future personnel housing allowances, determining the feasibility of constructing additional recreational facilities, predicting the impact of possible population changes, developing a method to evaluate contractor proposals, and facilitating the analysis of the courses of action.

A VFT Approach to Allocation of Manpower and Budget Cuts

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The National Air Intelligence Center (NAIC), like many Department of Defense (DoD) and civilian organizations, has been forced to undergo budget and manpower reductions. This year's resource allocation decision requires NAIC to identify both contracts and personnel to be cut. In order to reduce the amount of time and subjectivity involved in this important decision, a resource allocation model was developed to compare different alternatives. This model uses decision analysis with value-focused thinking to quantify the resultant impact of the chosen cuts. The impact was quantified based upon the NAIC Commander's values and preferences, which were used to build a value hierarchy. Each of the 61 contracts, as well as the 5, 10, 15 and 20% manpower cuts for the 18 organizations within NAIC, were evaluated against 49 attributes, which represented the Commander's values. Using multi-attribute utility theory, the subjective scores were multiplied by the commander's preference to arrive at an overall utility score. In addition to identifying the absolute best alternative, a rank ordering based upon the impact/cost ratio was supplied to the NAIC Commander. By including sensitivity analysis on the commander's preferences, NAIC could better understand their resource allocation problem and make a more-informed decision.

Air Staff Allocation of Military Family Housing Investment Funds

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Allocating resources is a difficult task when resources fall considerably short of the requirements. The task is further complicated when there are many different opinions on what requirements should have priority. The Air Staff Housing Division must decide how to allocate a $250M/year investment budget to best achieve the Air Force goals for military family housing. The decision is complex because requirements are far greater than the available resources and there are many conflicting objectives to consider.

This research uses value-focused thinking and multiattribute utility theory to develop a decision analysis model to assist the decision maker in selecting a budget strategy. A deterministic analysis (using Logical Decisions software package) on the data submitted from four Major Commands (MAJCOMs) demonstrates the model's capabilities by ranking 87 budget strategies based on how well each strategy meets the decision maker's objectives. The model allows for sensitivity analysis to display the effects of changes in the decision maker's preferences and changes in the input data.

The model provides a tool that allows the Air Staff to consider all objectives in making the optimal decision on allocating the military family housing investment funds. In addition to assisting the Air Staff in making the decision, the model provides a quantifiable, transparent, and defensible method to present the decision to the stakeholders. It also provides metrics to evaluate the effectiveness of the military family housing investment program in meeting Air Force goals.

Grenadier BRAT Warfighting Rapid Acquisition Program (WRAP) Requirements Analysis

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Grenadier Beyond-line-of-sight Reporting and Targeting (BRAT) device is a small, lightweight, manportable transceiver that receives location information from Global Positioning System satellite broadcasts and transmits unit identification, location, and other desired brevity coded messages to higher headquarters' command and control systems. Signals are relayed from Grenadier BRAT devices through existing satellite, aircraft, unattended aerial vehicle, aerostat, or tower systems.

The Grenadier BRAT Warfighting Rapid Acquisition Program Requirements Analysis was commissioned by the Battle Command Laboratory – Fort Leavenworth in May 1997. The objectives of the analysis included:

Determine Grenadier BRAT system-level capabilities and limitations, including capabilities of existing communications relay systems to process additional transmissions for Grenadier BRAT-equipped units.

Evaluate the potential value of Grenadier BRAT's contribution to Army deep force situational awareness, with emphasis on corps-sized forces in multiple warfighting scenarios.

Based on the previous evaluation, develop preferred quantities of systems for distribution within the Army force structure.

To meet the objectives of this study, TRAC and BCBL conducted a MAPEX (survey of participants) to examine two approved operational scenarios based on TRADOC's Division Design Analysis.

Candidate distribution plans were developed for each scenario and evaluated in the MAPEX in order to develop a recommended preferred distribution of systems. This paper documents the results of the study effort.

An Analytical Tool to Assess Aeromedical Evacuation Systems for the DoD

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The AMC Surgeon General sponsored this research to determine if the McDonnell-Douglas C-9A Nightingale should be replaced, and, if so, with what. The C-9A is the US Air Force's only dedicated aeromedical evacuation asset. Using tools based in Keeney's Value-Focused Thinking methodology, the Surgeon General's values for this decision were quantified, alternatives that addressed these values were generated, and those alternatives were evaluated using his values to suggest preferred alternatives.

F/A-18F Aft Crew Vehicle Interface (CVI) Enhancement Using Quality Function Deployment (QFD)

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Approved abstract unavailable at printing.

Optimizing the Integration of Modeling and Simulation into the Test and Evaluation Process

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The Army's Operational Test and Evaluation Command has initiated a program to integrate modeling and simulation into the test and evaluation process. The intent is to achieve more efficient use of resources in the process of maximizing the amount and the accuracy of the information used to evaluate the system under test. OPTEC and Logicon have collaborated in a program to develop the methodology necessary to implement the process.

A prototype methodology has been developed that operates at two levels within the overall test and evaluation cycle. At the top level, a mathematical program is used to select among feasible tests and M&S options to form an efficient test program. The model uses two measures of merit in the objective function: a measure of statistical bound on error of the test method, and its credibility in emulating the real-world performance of the system under test.

Credibility is measured at the second, lower level, in a process referred to as the Leveling Methodology. Conceptually, "leveling" amounts to the process of determining how well the test method – M&S or field test – emulates the real world situation of the system under test. The resulting credibility measure is akin to a measure of accuracy of the results that will be derived from the test. A measure of statistical bound on error for each test method is also determined at the lower level. The bound on error is a measure of precision of the test method, and is dependent on the number of replications of the test event that can be performed.

This presentation describes the prototype decision methodology and its application. We will describe the decision model as originally formulated and how the data is derived to support it. Methods for computing credibility and bound on error will be described, including fuzzy logic and Bayesian approaches. Finally, we will describe future work, including reformulation of the decision model and methods for determining credibility.

Facilitation Skills as Part of an Analysts Toolset

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Decision Analysis, while utilizing various resource allocation methods, multi-criteria decision making methodologies, and process modeling and redesign techniques, makes use of data often collected from subject matter experts. In addition to analytic expertise, facilitation skills can provide an analyst with the tools needed to collect more robust data in shorter periods of time in a group setting. An analyst who is also a skilled facilitator can lead a group through a well designed process in a fraction of the time that individual interviews would take. When used in the correct combination, analytic and facilitation skills lead to higher quality data collection and thus higher quality decision making.

Implementing an Investment Strategy Process for CVX

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The Navy has identified the need for a new class of aircraft carrier as a more affordable alternative to the current Nimitz-class design. Achieving a more affordable aircraft carrier will require a substantial R&D program for aircraft carrier-unique technologies, a program which has not existed for over 30 years. Facing development and execution of that R&D program, the CVX Program Office developed a comprehensive decision aid for R&D investment planning.

The decision aid is the result of a rigorous process that uses a multiple-model approach to capture warfighting impact and programmatic considerations for the wide variety of proposed research and development programs being considered for funding under the Future CV R&D Program. This paper will detail the 15-step process that has now gone through one complete cycle. The process is being used to support the R&D plan for CVX program input to the FY-2000 Program Objective Memorandum (POM-00). Features of the process include:

(1) a cooperative link between the CVX Program Office and its supporting activities in the technology community, the OPNAV Program Sponsor, and fleet representatives coordinated through COMNAVAIRLANT and COMNAVAIRPAC;
(2) electronic decision support software; and
(3) linear optimization techniques.

The process integrated elements of the Quality Function Deployment (QFD) methodology and the Analytical Hierarchy Process (AHP) to quantify the relative benefit of each potential investment alternative through warfighting contribution and taking into account the realities of program execution. These methods were facilitated by the use of a decision support software package that simplified the capture of thoughts of a large group of subject matter experts.

A linear programming technique is then used to optimize total benefit from a set of selected programs within given funding constraints. This model is now available to re-optimize the CVX R&D investment strategy based on variations that will occur in the budgeting process. The process can continue to be used as the CVX Program matures and will form the foundation for a life-cycle investment strategy throughout the CVX class service life.

Distributed Decision Support

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As budgets are shrinking, there is a growing need for the support of groups which are geographically dispersed. The integration of commercially available products on a platform which is Web enabled can meet the needs of a group which is looking to reduce travel costs. Implementation is relatively cheap and the technology allows for easy customization. Distributed electronic meeting support combined with the capability to build models and share results is an effective first step in providing Distributed Decision Support.

WG 29 – MODELING, SIMULATION AND WARGAMING – Agenda

Chair: Mr. Michael W. Garrambone, Veridian/Veda Operations
Cochair: Major Ken Dzierzanowski, TRAC-WSMR
Cochair: Major Leroy A. "Jack" Jackson, TRAC-MTRY
Cochair: Mr. Steven M. Friedman, Veridian/Veda Operations
Cochair: Ms. Maria M. Aquino, Lockheed Martin
Cochair: Major Philip B. Oglesby, Air Force Wargaming Institute
Advisor: Dr. Bruce W. Fowler, Technical Director and Deputy Advanced Systems Concepts Office

Room: ME-146

Tuesday, 1030-1200: MODELING OF C4ISR
Joint C⁴ISR Decision Support Center Modeling & Simulation Classification Tool
Mr. Harvey F. Graf, The MITRE Corporation
Dr. Russell Richards, The MITRE Corporation
Ms. Deborah Kelly, OASD(C3I) Decision Support Center

C2W Analysis and Targeting Tool (CATT): Modeling An Integrated Air Defense System (IADS)
Randall C. Bullard, GS-12, C2W Systems Analyst, Air Force Information Warfare Center

The State-of-the-Art in Simulation to C4I System Interfaces as Assessed at Army Experiment 4 (AE4)
Joe Jennings, Lead Staff, The MITRE Corporation
Wes Hamm, Lead Staff, The MITRE Corporation

Alternate Presentations

Representing C4ISR in JWARS: Concepts, Models, and Issues
LTC Dan Maxwell, OSD PA&E, JWARS Office

C4I Analysis Across a DIS Network
CAPT Dave Smith, Det 4, 505 CCEG (TACCSF)
Michael Gray, Senior Analyst, TBE Contractor (TMDSE)
George T. Cherolis, Senior Analyst, BDM Federal

ADS and Analysis - Lessons from STOW 97
Gary Q. Coe, IDA

Tuesday, 1330-1500: WARGAMES AND EXERCISES
A Planning Tool for Operational Fires
Captain, William M. McLagan, Colonel William F. Crain, United States Army Concepts Analysis Agency (CAA)

Lessons Learned from the Assessment of Task Force XXI (TF XXI)
Major Kenneth Dzierzanowski, TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR)

Model and Scenario Integration Efforts in Support of Evolving US Navy/Marine Corps System Development and Warfighting Concepts
David P. Kelley, TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR)

Pre Analysis of the Global Engagement 97 Scenario (SECRET)
David B. Lee, Systems Simulation Solutions Inc

Global Engagement 97 (SECRET)
Kenneth E. Lavoie, Air Force Wargaming Institute
Capt. Robert Payne, Air Force Wargaming Institute
Dr. Daniel B. Fox, Rand Corp
Michael Griffin, Modern Technology Solutions Inc

Alternate Presentations

Improving C2 Wargaming Using Tactical Displays
Wayne J. Pavalko, Johns Hopkins University Applied Physics Laboratory

Fundamentals of Wargaming
Lt. Col. Ramon Cortex, Major Tim McIlhenny, Air Force Studies and Analyses Agency
Major Tim McIllhenny, Analyst, Wargame Branch

Wednesday, 0830-1000; NEW DEVELOPMENTS IN MODELING, SIMULATION, AND WARGAMING
Marine Corps Analytic Modeling and Simulation
LtCol William A. Sawyer, Studies and Analysis Division, Marine Corps Combat Development Center

A Graph and Network Component for a Loosely Coupled Planning System
Major Leroy A. "Jack" Jackson, US Army TRADOC Analysis Center-Monterey

Attrition Curves for Combat Models Using Force Ratio
LCDR Aasgeir Gangsaas, Naval Analyst, J-8, Warfighting Analysis Division.

Alternate Presentations

The Combat XXI Model
Charles W. (Chad) Mullis, US Army TRADOC Analysis Center-White Sands Missile Range
Lt. Col. William A. Sawyer, Studies and Analysis Division, Marine Corps Combat Development Command

A Flexible Automated Behavior System
Camillus W. D. "Dave" Hoffman, US Army TRADOC Analysis Center-White Sands Missile Range

Wednesday, 1030-1200: MODELING AND SIMULATION STUDIES
C-17 Airdrop Simulation
Capt. Scott Fox, USAF Air Force Institute of Technology
Lt. Col. T. Glenn Bailey, USAF, Air Force Institute of Technology
LTC William B. Carlton, US Army, Air Force Institute of Technology

Soldier Station: A Dismounted Infantry Analysis Tool for Non-lethal Weapon Technology
David Ohman, US Army TRADOC Analysis Center-White Sands Missile Range

Optimal Mix of Army Aviation Assets
CPT Jon L. Shupenus, United States Military Academy, Operations Research Center

Alternate Presentations

A Generic Parameterized Model of Active Protection Systems for Military Vehicles
John D. Pinder, Doctoral Fellow, RAND Graduate School

Executing the Global Engagement Strategy in the Halt Phase of Two Major Theater Wars: (SECRET)
Major Robert A. Morris, Campaign Analyst, Air Force Study and Analyses Agency

Wednesday, 1330-1500 : SPACE AND TARGETING SYSTEMS
The Use of Operational M&S in Test, Evaluation and Wargaming: GPS on the Battlefield
Second Lieutenant David Ozmen, Space and Missile Center (GPS Joint Program Office)
Steve Friedman, Veridian/ Veda Operations

The Necessity for Integrating Space Assets into Campaign Analysis
Capt James R. Hunter, Space and Missile Center, Systems Engineering and Integration
Capt Mark A. Powers, Space and Missile Center, Systems Engineering and Integration

Effects of Simulating Tactical Unmanned Systems
Kevin Young, US Army TRADOC Analysis Center-White Sands Missile Range

Alternate Presentations

JTCG/ME Automated Products for Planning
Dr. Erwin Atzinger, Coordinator JTCGME, US Army Materiel Systems Analysis Activity (AMSAA)

Department of Defense Joint Modeling and Simulation System (JMASS)
Julie Doerr, OUSD (A&T), DTSE&E.
John Ferguson, Science Applications International Corporation

Thursday, 0830-1000; MS&W WEIRD STUFF

Pursuing Techniques to Support the 21st Century Warrior
Dr. Alfred G. Brandstein, Marine Corps Combat Development Command, Studies and Analysis Division (C45)
Dr. Gary E. Horne, Marine Corps Combat Development Command, Studies and Analysis Division (C45)

Representing Human Response to Moving Ground Targets in Search and Target Acquisition Models
Regina W. Kistner, US Army Material Systems Analysis Activity (AMSAA)
Scott Schoeb, US Army Material Systems Analysis Activity (AMSAA)

A History of Model Usage within the Army by a Practitioner of the Black Art of Simulation
Donna K. Vargas, TRADOC Analysis Command-White Sands Missile Range

Alternate Presentations

Warfighting Analysis in a Ruck Sack (WARS)
Colonel William Forrest Crain, US Army Concepts Analysis Agency (CAA)
Major David E. Bassett, US Army Concepts Analysis Agency (CAA)

Use of High Fidelity Combat Simulations to Support Research and Development Investment
John A. O'Keefe IV, US Army Soldier and Chemical/Biological Command (PROV)
Robert T. McIntyre III, Simulation Technologies, Inc

Thursday, 1030-1200

COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday, 1330-1500 NEW MODEL INITIATIVES

Wargame 2000 Verification and Validation
Dr. Dale K. Pace, The Johns Hopkins University Applied Physics Laboratory

Army Advanced Concepts and Requirements (ACR) Analytical Support
John A. Riente, Technical Advisor to the Deputy Chief of Staff for Operations and Plans, HQDA

USMC Joint Simulation System (JSIMS) Operational Testing Strategy
Peter H. Christensen, The MITRE Corporation
Sara McCaffey, The MITRE Corporation
Gary Brisbois, The MITRE Corporation

Alternate Presentations

Man-in-the-Loop Distributed Simulation and VV & A (...and things that go bump in the night!)
Chuck Sadowski, Veridian/ Veda Operations

Conceptual Models of the Mission Space (CMMS): Basic Concepts, Advanced Techniques, and Pragmatic Examples
Jack Sheehan, Defense Modeling and Simulation Office (DMSO)
LTC Terry Prosser, USA, Joint Warfare System (JWARS)
Major Harry Conley, USAF, Joint Simulations Systems (JSIMS) Joint Program Office (JPO)
LTC George Stone, USA, Warfare Simulation 2000 (WARSIM) Functional Description of the Battlespace (FDB)
Capt. Kevin Yentx, USAF, National Air and Space Simulation (NASM)
Janet Morrow, US Army National Ground Intelligence Center (NGIC)

The Next Generation Mission Model (NGMM)
Steven J. Wourms, Air Force Materiel Command, Modeling and Simulation Integration Office (MSIO)

WG 29 – MODELING, SIMULATION, AND WARGAMING - Abstracts
Room: ME-146

Tuesday, 1030-1200

Joint C⁴ISR Decision Support Center Modeling & Simulation Classification Tool

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In 1995, the C^4ISR Decision Support Task Force (DSTF) determined that there were many modeling and simulation (M&S) tools used to support C^4ISR analyses, but that the existing tools have significant weaknesses in areas important to C^4ISR modeling. As a consequence of this, the C^4ISR Decision Support Center is building an on-line database of tools (models, simulations, expert elicitation, decision analysis, wargames, etc.) with a two-fold purpose in mind:

- Assist users in selecting tools that meets their particular C^4ISR analysis requirements.
- Provide a comprehensive source of information to facilitate the assessment and improvement of C^4ISR M&S capability.

MITRE, in support of this effort, has developed a taxonomy and a tool to capture information about the capabilities of M&S applications. The tool facilitates collection of information currently unavailable in DoD M&S catalogs. It characterizes the capabilities of the models and simulations in a consistent and objective way using an object-oriented approach. Objects (ground, air, sea, and space) and C^4ISR Functions/Processes identify "what" is modeled, and the object attributes and modeling methods (Level of Aggregation, Movement, etc.) describe the "how" or level of detail to which the objects or functions are modeled. Together, the "what" and "how" capture and lead to an understanding of each model's capabilities. This paper describes the M&S classification tool. The use of the resultant database for tool selection and M&S capability assessment are also discussed.

C2W Analysis and Targeting Tool (CATT): Modeling An Integrated Air Defense System (IADS)

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The C2W Analysis and Targeting Tool (CATT) is a computer model of an operational Integrated Air Defense System (IADS). The Command and Control Warfare (C2W) Analysis Division of the Air Force Information Warfare Center (AFIWC) uses this simulation to provide information superiority to the acquisition, intelligence, and operational communities. The CATT encompasses end-to-end modeling of IADS processes including detection, tracking, communication, weapons control and allocation, decision making, engagement, and identification. This tool promotes understanding the IADS processes in detail and how those processes function together. With this knowledge, we can optimize the use of C2W and Information Warfare (IW) assets. The CATT provides a seamless analytical capability covering the operational IADS of a specific country. The model's plug-and-play capability allows the integration of existing electronic warfare and intelligence support models. It's software code is Ada and is Distributive Interactive Simulation and Higher Level Architecture compliant. Current CATT uses include evaluating aircraft for acquisition and modeling optimal ingress/egress routes for mission planning. The CATT was displayed at the AF 50th Anniversary, presented by the Air Intelligence Agency Commander to CORONA, and briefed at the IADS Conference. The AFIWC is incorporating this tool into upcoming Air Force and Joint exercises, and will nominate the model as an Advanced Concept Technology Demonstration for the Information Superiority Battle Lab.

The State-of-the-Art in Simulation to C4I System Interfaces as Assessed at Army Experiment 4 (AE4)

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In FY97 U.S Army TRADOC sponsored a series of experiments collectively known as AE4. The intent of these experiments was to assess the ability of existing simulations and C4I interfaces to stimulate the C4I systems comprising the Army Battle Command System (ABCS) for support of training in the use of Situational Awareness. The experimental hypothesis was: "If a functional simulation/C4I architecture is developed that links constructive and virtual simulations to Army XXI C4I systems then soldiers can use it to practice using Army XXI Situational Awareness." Three experiments were conducted: the first used a variety of interfaces together with CBS, EADSIM and FIRESTORM to stimulate the ABCS systems from division to battalion level, the second combined different interfaces with a federation of DIS simulations including Eagle (with the SIU, a DIS translator), ModSAF, EADSIM and others to stimulate ABCS systems to the individual platform level, and the third combined DIS simulations, individual combatant simulators, and a SIMNET vehicle simulator to stimulate ABCS and Land Warrior System (LWS) C4I systems for dismounted infantry.

The top-level finding of the experiment report was that the current state-of-the-art in simulation/interface systems is capable of providing minimal support for training in the application of situational awareness. This paper summarizes the observations, conclusions and recommendations in the experiment report and provides the rationale behind the top-level finding. The paper also identifies some of the technological obstacles that will have to be overcome before simulations will be able to provide highly realistic stimulation to C4I systems.

Alternate Presentations:

Representing C4ISR in JWARS: Concepts, Models, and Issues

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The Joint Warfare System (JWARS) is the next generation of theater level campaign model, currently being developed in the Office of the Secretary of Defense for use by the Joint Staff, Warfighting Commands, and Services. JWARS is an analytical model whose design requirements include the ability to provide a "balanced" representation of joint warfare. This includes representing explicitly the effects that changes in the Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems may have on a campaign success. This presentation describes the concepts that are being used to represent C4ISR in JWARS. Additionally, the progress of the development effort and known modeling issues will be discussed.

C4I Analysis Across a DIS Network

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Many programs have successfully integrated Joint distributed simulations and real systems using DIS protocols to provide effective simulation of the Joint Warfare environment. Few programs have been able to fully analyze the events that occurred during these exercises or experiments. The Tactical Air Command and Control Simulation Facility (TACCSF) has established a simulation and data collection methodology, architecture, and analytical tool set capable of computing a robust set of C4I MOE/MOP for tests conducted on a DIS network linking virtual, and constructive simulations in a Joint virtual battle space. No new DIS PDUs or additional bandwidth during test execution is required. Each distributed site captures the required data from its simulations or systems during realtime and then does a simple reformat and transmits the data across the T1 to other sites. The data files from distributed sites are then merged in a MS Access relational database to generate a combined Trial Event History for analysis. Examples of key queries used for coordinate and time transformations will be shown. In addition a flow chart of the complex queries which merge truth location and identity information from DIS Entity State PDUs with the appropriate recorded TADIL messages (perceived information) will be discussed.

This presentation will cover the current state of TACCSF's ability to provide accurate and timely data collection on critical operational events to facilitate analysis of performance and effectiveness of Joint operational concepts or C4I systems being tested across a DIS network. Operational performance measures will be addressed from the perspective of an air and missile defense analyst.

ADS and Analysis - Lessons from STOW 97

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STOW 97 is an Advanced Concepts Technology Demonstration for demonstrating the effectiveness, efficiency, and potential of the Advanced Distributed Simulation (ADS) in facilitating the training and mission rehearsal objectives of the commanders and staffs of the Joint Task Force and its components. However, the STOW technologies have implications in areas beyond training that include analysis.. On balance, the requirements for analysis are changing as the result of a new global environment and technological capabilities. This presentation uses lessons from STOW 97 to examine how ADS can and should support analysis in the future, given emerging analytical challenges that require new analytic methods and tools. Some particular analyses where ADS can have a substantial impact are identified - particularly information processes. STOW 97 was interfaced with several real world C4I systems including GCCS, MCS-P, CTAPS, AFATDS, JSTARS, and E-OPS. These interfaces permitted real world processes to interact with simulated events realistically. STOW 97 included sophisticated ways for communication between real world activities and simulated events that allows new ways of analyzing processes such as intelligence, battle damage assessment, resource allocation, planning, and logistics. For example, an air tasking order was implemented effectively in the simulation. Simulated aircraft commanders reported on mission completions. Intelligence agents, desiring more specific information about the damage could task sensors to look more closely. These included electronic and optical surveillance. Also, terrain analysis was conducted. This discussion is balanced with a consideration of the challenges of ADS. The presentation then considers the incorporation of ADS within a broader research plan highlighting some of the special properties of ADS that make it useful for analysis and some new analysis techniques that should be considered, particularly in experimental design. Also, some technological challenges are identified to improve ADS for analysis. The presentation advocates the development of new approaches to data analysis and a greater dependence on visualization vice statistical analysis.

Tuesday, 1330-1500: WARGAMES AND EXERCISES

A Planning Tool for Operational Fires

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The Planning Tool for Operational Fires (PTOF) is a powerful yet simple dynamic model and methodology that was literally developed overnight by analysts at the US Army Concepts Analysis Agency (USACAA). This model and methodology were developed as a planning tool to model operational fires to support course of action analysis for the US Army Central Command (ARCENT) G-3 Plans staff during exercise Roving Sands '97 held at Ft. Bliss, TX from 20-26 April 1997. This model was developed to assess the current effects of operational fires for the courses of action developed for the Roving Sands exercise. This model is a valuable planning tool available to the commander which is capable of estimating the future effects of planned fires for different courses of action over of time. This model also allows the commander the ability to perform rapid trade-off analysis to predict the effects of changes and modifications to operational fires for alternative courses of action, branches, and sequels. Operational fires consist of those assets used to execute joint attack operations and deep fires in support of the deep battle. This model synchronizes these operational fires with operational maneuver. During Exercise Roving Sands, the Commander, ARCENT and the CINC, US Central Command (USCENTCOM) directed that the PTOF model and methodology be used in future analysis to assess ARCENT and USCENTCOM OPLANs.

Lessons Learned from the Assessment of Task Force XXI (TF XXI)

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This presentation develops the process, models, and lessons learned from the U.S. Army's Training and Doctrine Command (TRADOC) Analysis Center (TRAC) support of TF XXI. TRAC's purpose was to assess the value gained by Digitization of the Battlefield (DOTBF). DOTBF is the most important challenge that the Army will address in this decade and required progressive modeling and simulation. DOTBF is defined as: "the application of technologies to acquire, exchange, and employ timely information throughout the battlespace, tailored to the needs of each commander, shooter, and supporter."

Assessing digitization was accomplished in multiple phases. The first phase was to replicate field exercises with increased fidelity. The second step was to calibrate (verify) that the selected scenarios were representative. Calibration was followed by "digitizing" the scenarios. Additionally, TRAC supported the TF XXI Advanced Warfighting Experiment (AWE) at the National Training Center (NTC), Fort Irwin, California. The AWE was a critical step in the evaluation of information technologies on combat effectiveness. Finally, detailed analysis was conducted.

TRAC used several techniques to evaluate digitization. For instance, digitization analysis required model modification. The Combined Arms and Support Task Force Evaluation Model (CASTFOREM) was given the increased capability to simulate maneuver logic, communication transmission times, and decision making. In consonance with the MORS theme of "Preparing for Military Operations Research in the 21st Century," the TF XXI assessment provided insights into how Modeling, Simulation, and Wargaming could be improved today and in the future.

Model and Scenario Integration Efforts in Support of Evolving US Navy/Marine Corps System Development and Warfighting Concepts

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The Advanced Amphibious Assault Vehicle (AAAV), MV-22, and Landing Craft, Air Cushion (LCAC) make up a triad of US Navy/Marine Corps advanced systems that will enable implementing advanced war fighting concepts in futuristic battles. These systems will help enable the US Navy/Marine Corps to radically alter the nature of amphibious operations. Landing forces will possess their own mobility systems and have the ability to independently navigate across vast expanses of ocean surface and penetrate the enemy's shoreline at points of their choosing. Freed from the constraints of securing a large beachhead, the commander will be able to focus on the enemy and begin the

landing force's maneuver from over the horizon. These new capabilities will enable tactical commanders to make decisions, as the situation develops to exploit enemy weaknesses and maintain the momentum of the attack from the ship to the objective. This combination of maneuver warfare philosophy and emerging technologies will provide the naval force with enhanced combat effectiveness.

The US Army TRADOC Analysis Center (TRAC) was sponsored by the DRPM-AAAV to help support the engineering design phase of the AAAV development by integrating three high-resolution amphibious scenarios into the combat simulation model CASTFOREM and conduct force-on-force analysis. These scenarios incorporated *Ship-to-Objective Maneuver (STOM)* and enabled the DRPM-AAAV program office to study the AAAV within the confines of this advanced war-fighting concept. This paper will describe the process TRAC used to upgrade the land combat simulation model CASTFOREM in order to represent Naval Surface Fire Support, Marine Air, the AAAV, and other Marine Air-Ground Task Force (MAGTF) elements.

Pre-Analysis of the Global Engagement 97 Scenario (SECRET)

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Global Engagement 97 was an exercise sponsored by the Chief of Staff, United States Air Force. The game emphasized basing and employing forces, force structure adequacy, and appropriate courses of action for a simulated major theater conflict. System Simulation Solutions, Inc (S3I), in contact with Air Force Studies and Analyses Agency and the Air Force Wargaming Institute, conducted a pre-analysis of the Global Engagement assessment teams. Analysis consisted of establishing a baseline case and several excursions using the THUNDER campaign model. The baseline case described the forces and capabilities of forces in the conflict and probable course of action for both sides. Metrics examined included ground movement, attrition, air losses, and munition expenditures. Excursions assessed the impact of political and logistics constraints.

Global Engagement 97 (SECRET)

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The Global Engagement wargame series was established by the Chief of Staff of the Air Force as an integral part of the service's long range planning process. The games are designed to provide joint warfighters with the opportunity to challenge emergent concepts, ideas, and assumptions. Global Engagement 97 was set in northeast Asia in 2012 with a specific focus upon: space, information operations, mobility and logistics. The game involved three parallel seminars independently examining the issues, supported by three suites of nine somewhat disparate models. This presentation will summarize the scenario, game design concept, model supported adjudication process, special focus area insights, and some of the operational-strategic level insights of game play.

Alternate Presentations

Improving C2 Wargaming Using Tactical Displays

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Command and Control (C2) wargaming for the development and evaluation of Concepts of Operations (ConOps) is becoming increasingly important when live exercises are not economical or feasible, or when future systems are being considered. Typically, such wargames are composed of service players performing their normal or proposed functions, but at simulated consoles with simulated blue and red forces. In some cases, multiple simulations or multiple geographic locations are used in which case the wargame is distributed using the Distributed Interactive Simulation (DIS) standard. Often, the effort spent familiarizing the service players with the simulations and displays is time consuming, and the lack of familiar interfaces reduces the value of an otherwise well-constructed wargame.

This presentation describes an effort to connect an existing prototype Navy AEGIS anti-air warfare display to the Extended Air

Defense Simulation (EADSIM) for use in C2 wargaming. This approach leverages off existing work on prototype tactical displays and also on Department of Defense (DoD) investment and continued use of EADSIM. The initial results show that this approach is practical, economical, and offers a way to increase the realism and credibility of C2 wargames.

Fundamentals of Wargaming

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Fundamentals of Wargaming is a wargaming primer that discusses the basics of military wargaming. This primer is an educational tool. The primer provides a clear definition of what a wargame is and what it is not and it explains wargaming strengths and weaknesses. This primer examines the uses of wargaming in DoD and the Air Force. Finally, the primer discusses the dangers and misuses of wargaming.

Wednesday, 0830-1000; NEW DEVELOPMENTS IN MODELING, SIMULATION, AND WARGAMING
Marine Corps Analytic Modeling and Simulation

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The Marine Corps has instituted a new Mission Area Analysis (MAA) process to identify operational requirements and deficiencies. In the past, the MAA process was highly subjective and lacking in analytic rigor. The new methodology extensively employs the capabilities of models and simulations to provide quantifiable findings as the basis for the Marine Corps Combat Development Process. Prior to this effort, the on-site analytic modeling capability of the Marine Corps Development Command (MCCDC) was limited. The newly formed MAA Branch conducted a survey of existing and developing simulations, and produced a plan to rapidly expand MCCDC's analytic tool set. An initial suite of models was selected and installed to provide insight across the functional areas of maneuver, fires, C4, ISR, logistics, and force protection. The very nature of Marine Expeditionary Operations across the domains of land, sea, and air added to the complexity of the task. This paper will discuss the evolving analytic modeling capabilities of the Marine Corps.

A Graph and Network Component for a Loosely Coupled Planning System

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Military planning systems must evolve to meet the challenges of conducting military operations in the information age. The Department of Defense Joint Vision 2010 and the Air Force New World Vistas suggest the next generation of military planning systems will accelerate the tempo of analysis, operate over computer networks and on different computer platforms, and incorporate simulation technology for mission planning. Even the best-integrated planning tools today do not provide adequate interoperability, platform independence, or extensibility. Future planning systems must address new situations and needs of decision-makers that designers have not yet anticipated. These planning systems will feature an open architecture enabling new functions and capabilities to be added without disruption.

Incorporating graph and network models, and associated algorithms, into a dynamic military planning system has great potential for overcoming the shortcomings noted above. Traditional users of graph and network models include planning, optimization, and simulation. Graph and network models, implemented in a loosely coupled dynamic planning system through a set of Java interfaces may provide the flexibility and adaptability needed in military planning and decision-making systems of the future. This presentation describes work to design and implement an extensible Java library of graph and network algorithms for military planning in dynamic, distributed systems.

Attrition Curves For Combat Models Using Force Ratio

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A common problem with legacy campaign models is the lack of pedigree in critical data supporting the model. Without proper documentation, the study, used for decision making, can result in both embarrassing questions and, in the worst case scenario, the wrong course of action.

In preparation for a major study using our theater level campaign analysis model, a thorough review of input data was conducted. One critical area was the review of the attrition curves used to determine equipment and personnel casualties as a function of force ratio and posture. No one in our organization could explain these relationships, nor was there any documentation regarding their origin. Using historical data, numerical analysis, and graphical techniques, new attrition curves were developed, tested, and certified for use. Additionally, the steps used to gather, analyze the data, and test the derived attrition curves were documented so that someone else could reproduce the results. This paper provides both the steps in the development of attrition curves for theater level campaign models; and perhaps more importantly, a case study that others might use to address similar problems.

Alternate Presentations

The COMBAT XXI Model

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COMBAT XXI, an integral slice of the OneSAF Program, is being developed at TRAC-WSMR as a collaborative effort between the Army TRADOC Analysis Center and the Marine Corps Combat Development Command to build a state-of-the-art, high resolution, combat simulation. COMBAT XXI will meet the joint analytic requirements of both the Army and Marine Corps for entity-level modeling. Building upon an HLA foundation and the proven algorithms of the existing CASTFOREM model, COMBAT XXI will provide a useful complement to JWARS by enabling detailed analysis of joint operations at the tactical level of warfare. This new model will be a composable, next generation CGF that can represent a full range of operations, systems, and control processes from individual combatant and platform to the battalion level, with a variable level of fidelity that will support both the research, development and acquisition (RDA) and advanced concepts and requirements (ACR) M&S domains. It will accurately and effectively represent specific activities of ground warfare (engagement and maneuver), command, control, communications, computers, and intelligence (C41), combat support, combat service support, and close air support. It will also employ appropriate representations of the physical environment and its effect on simulated activities and behaviors. This paper presents an overview of the development process as well as a status update.

A Flexible Automated Behavior System

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Battlefield cognizance and intelligent actions/reaction by Computer Generated Forces (CGF) remain as elusive as the Holy Grail. The requirement has become even more visible with the introduction of the virtual world where the behaviors (or misbehaviors) of CGF are so readily apparent. Instantiated generic behaviors which do not account for mission, enemy, terrain, troops, and time available (METT-T) will always be limited and at best marginally effective for applications where doctrinal CGF behaviors can affect the results. The interactive feature of Semi-Automated Forces (SAF) has proven to be no panacea for improving behavioral performance due to operator-SAF interaction limitations. Beyond the domain of demonstrations and research, there remains room for a substantial improvement in the art and science of automated human decision-making to support practical applications of combat simulations. Overlooked or eschewed for the promise of superior, new technologies (yet undelivered), the Expert System Inference Engine offer a paradigm for modeling cognitive behaviors and military doctrine which works as well as any attempted in newer simulations. The compelling arguments for the approach are in its flexibility, adaptability, transparency, and subject-matter-expert/user modifiability at a bargain cost!

This paper will present the view point of the military user of simulations: how he thinks about preparation for combat, how doctrine is applied differently to each situation, and the use of simulations for training or analysis. The paper will consider the various types of human response, cognition, and command and control. Considering all of these military requirements, the paper introduces the Expert System Inference Engine methodology. It discusses why an Expert System Inference Engine is an arguably competitive approach to handling the wide spectrum of complex requirements involved in modeling military doctrine and behaviors. Lastly, it explains how the Expert System is able to satisfy varying fidelity requirements across simulation domains, how it can mitigate the verification and validation (V&V) time and cost impact, and why the cost is so competitive.

Wednesday, 1030-1200: MODELING AND SIMULATION STUDIES

C-17 Airdrop Simulation

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We developed an object-oriented simulation that models the airdrop mission of the newest U.S. transport aircraft, the C-17 Globemaster III. The simulation, written in MODSIM III, is based on three object types that represent the C-17, the paratroopers, and the wake vortices generated by the aircraft's wing tips. The aircraft object provides the required aerodynamic constants for simulating the wake vortices off each wing tip; the wake vortex object includes both a position algorithm and a vortex decay model; and the paratrooper object implements a 6-degree of freedom trajectory model. The simulation outputs include complete trajectory information for all paratrooper objects, and identifies the maximum radial velocity and velocity gradients encountered by each paratrooper during their decent. We demonstrate the model with two case studies. First, we create a "Risk Assessment Tool for the Ground Commander." This tool quantifies the risk associated with paratrooper/vortex encounters in various formations with a quantitative measure, the potential encounter rate (PER). The PER is directly related to the aircraft formation, where the separation between elements significantly affects a contingency or combat scenario. Second, we provide a visualization of the simulation results on a Silicon Graphics Onxy2 Visualization Supercomputer in a 3D virtual environment, and demonstrate its use as an interactive tool for mission planning and prototyping of new aircraft formations or tactics.

Soldier Station: A Dismounted Infantry Analysis Tool for Non-lethal Weapon Technology

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Soldier Station is a Distributed Interactive Simulation (DIS) networked, Human-in-the-Loop (HITL) 3D virtual dismounted infantryman (DI) simulator with underlying constructive model algorithms for movement, detection, engagement, and damage assessment. It was developed to analyze DI issues pertaining to individual combat effectiveness, situational awareness, command and control, and tactics techniques and procedures. Soldier Station is unique in its design to integrate virtual and constructive simulations to provide analytical capabilities. It represents a significant reduction in project risk while offering significant advantages over building the simulation from scratch. The constructive model that Soldier Station currently engages with and/or against is JLINK (Janus Linked to DIS).

Recently, it has been used in two phases of a three phase study to evaluate the use of Non-lethal Weapons/Technologies in different terrain environments and the decision making process used by the Human-in-the-Loop to deploy such weapons. Significant enhancements have been mad3 to JLINK to incorporate the effects of non-lethal weapon technology against dismounted human entities and some protective postures to allow the receiving entity some counter-measures against such weapons. This paper describes the joint usage of Soldier Station and JLINK for the Non-lethal Weapon Concept Analysis Study. The model enhancements; non-lethal weapon data descriptions and data requirements; the tactics, techniques and procedures (TTP) employed; and plans for future non-lethal weapon work are presented.

Optimal Mix of Army Aviation Assets

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The Army has specific ideas concerning the force structure of future attack helicopter battalions following the introduction of AH-64D Longbow Apache and RAH-66 Comanche helicopters. This presentation will: (1) investigate the evolution of, and plans for, heavy division attack helicopter battalion organization; (2) describe modeling procedures for studying advanced helicopter characteristics in a combat simulation software package; and (3) investigate the effectiveness of alternative future attack helicopter battalion designs.

Alternate Presentations

A Generic Parameterized Model of Active Protection Systems for Military Vehicles Survivability

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A Generic Parameterized Model of Active Protection Systems for Military Vehicles Survivability is an important characteristic of military vehicles, since they are required to operate in hostile environments where they may be subject to enemy attacks. One approach to increasing the survivability of a vehicle is to improve its offensive capabilities, so that it can eliminate potential enemy threats prior to an attack. The alternative is to provide the vehicle with the ability to defend itself. The defensive techniques used to protect military vehicles have evolved over time as weapons were designed to overcome existing defenses. Traditional camouflage, concealment and deception techniques aimed at avoiding detection have improved gradually and been augmented by ever more advanced passive and reactive armor. In the case of tanks, heavy reliance has been placed on increasingly sophisticated armor to enable the vehicle to absorb and survive attacks by specially designed anti-tank weapons. This extra armor has, however, greatly increased vehicle weight, and in turn made it costly and difficult to rapidly deploy armored forces to where they are needed. Active protection systems (APS), which detect and respond automatically to incoming weapons, began to emerge in the 1980=92s. Several such systems are currently operational, and a variety of new and improved APS technologies and concepts are now under development in the U.S. and abroad. If the systems that emerge are sufficiently effective, robust, and light-weight then APS will provide an attractive alternative to thicker, or more sophisticated armor. This trade off would enable the deployability of future vehicles to be

improved without sacrificing survivability, and make some type of integrated APS a standard feature on most future military vehicles.

This presentation begins with a brief overview of military vehicle defense in general, and active defense in particular. The conceptual framework presented at the outset illustrates how sensors and countermeasures are integrated in an APS. A classification scheme is then developed and used, along with some other important considerations, to evaluate several existing APS concepts. The insights gleaned from this examination of current APS concepts was used to design a parameterized model of a generic APS, which was then implemented in a force-on-force simulation (JANUS). This model is described briefly, and then applied to a few illustrative examples. The presentation concludes with a discussion of the results and findings of a preliminary analysis of the performance and military utility of APS within the context of an Army After Next scenario.

Executing the Global Engagement Strategy in the Halt Phase of 2 Major Theater Wars (SECRET)

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This study was conducted by AFSAA/SAAC using the THUNDER Campaign warfare model. It is an excursion from the 2003 DPG baseline study conducted be AFSAA/SAAG in 1996 and examines the ability of the expeditionary Air Force and other Joint forces to rapidly and Decisively engage, HALT, and Defeat an aggressor by implementing the Global Engagement Strategy. Measures of Merit were selected that provided a comparative analysis of the 2003 DPG baseline and include: FLOT movement, air and ground attrition, force ratios and transportation throughout. Time required to accomplish these MOMs was a key, though objective, element of the measures. In addition to reducing the depth of penetration, the resulting level of attrition and synergistic effects of the Global Engagement Strategy as applied during the HALT Phase provides the JFC and NCA an increased range of options for prosecuting or ending hostilities.

Wednesday, 1330-1500 : SPACE AND TARGETING SYSTEMS

The Use of Operational M&S in Test, Evaluation and Wargaming: GPS on the Battlefield

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GPS provides the Warfighter with precise position, velocity and timing information on the battlefield. This information can give the US and Allied Forces a decisive advantage in navigation, communications, force enhancement, and precision weapons employment. Recently, studies have investigated the effects of a challenged EW environment on the operational use of GPS-aided weapon systems. This paper addresses the use of modeling and simulation to assess the impacts of this environment on the battlefield and how these same methods can be used to enhance operational and developmental test and evaluation, as well as to support exercises and wargames. An analytic approach for constructive modeling will be outlined, along with potential applications for virtual and live simulations.

The Necessity for Integrating Space Assets into Campaign Analysis

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Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, & analysis (MS&A) community must take a hard look at the design and implementation of the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Effects of Simulating Tactical Unmanned Systems

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The purpose of this project is to investigate a means of modeling Tactical Unmanned Systems (TUS) at night in a Deliberate Attack European Scenario to provide assessments of the TUS reconnaissance, surveillance, and target acquisition (RSTA) capabilities. One goal is to integrate the RSTA functions to provide a common intelligent picture for the maneuver elements. That will enhance combat system platforms with more timely and accurate targets, provide Situational Awareness (SA) of the threat systems, and in hazardous RSTA situations allow the absence of human presence. To accomplish this task a new scenario was developed with improved decision logic within the CASTFOREM combat simulation model to simulate the Tactical Internet, complex maneuver algorithms, communication networks that include voice transmission duration times, and command and control methodologies based on a threat intelligent picture.

The new high resolution scenario (HRS 64) developed at TRAC, depicts night reconnaissance, counter-recon operations, dismounted infantry fight, and a early dawn TF Deliberate Attack. The presentation of Red (enemy) includes improved logic to simulate a more realistic crew coordination in Armored Fighting Vehicles (AFV's), command and control based on a intelligent picture from voice communication, complex maneuver algorithms using inner visibility lines for concealment and engagement positions, and ambush tactics based on the intelligent picture.

Alternate Presentations

JTCG/ME Automated Products for Planning

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The Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) has developed a variety of CD-ROM products to support the Joint Munitions Effectiveness Manuals (JMEM) Air-to-Surface, Anti-Air, Surface-to-Surface, and Vulnerability Working Groups. Our primary goal is to provide non-nuclear munitions effectiveness information for operational commanders, weaponeers, weapon system designers, testers, analysts, trainers, logisticians, and DoD targeteers and planners. JTCG/ME publications are Joint Service authenticated field manuals and source documents for the Armed Forces of the United States. Many volumes have also been provided to NATO and other allies. By performing jointly sponsored military studies and evaluations and marshalling expertise from all services, the JTCG/ME effectively supports mission accomplishment for our soldiers, sailors, and airmen.

As of January 1997, the JTCG/ME has distributed approximately 164 paper JMEMs, 371 special reports, and 771 foreign information releases. Since 1995, many JTCG/ME products developed by the working groups have been distributed via electronic media. These CD-ROMS or diskettes are stand-alone products and accompany JMEMs. There are three published CD-ROMS: JMEM/Air-to-Surface Weaponeering System (JAWS); World Artillery and Mortar Systems (WAMS); and Special Operations Target Vulnerability and Weaponeering Manual. Currently under production are the Joint Anti-Air Combat Effectiveness (J-ACE) and World Infantry and Tank Systems (WITS) CD-ROMs. Each CD-ROM product provides a single source of information on weapons effectiveness against specific targets, to include available effectiveness data and the methodologies used to generate the data.

This presentation and demonstration will focus on one of CD-ROM products, JAWS, or WITS. JAWS is the single source for Air-to-surface weaponeering and target vulnerability. This CD-ROM hypertext document includes all JMEM/AS manuals and weaponeering computer programs needed to accomplish Air-to-Surface weaponeering. WITS, a surface-to-surface hyper document distributed on CD-ROM, provides a single, uniform source of data for US and foreign tank and infantry weapon systems versus various targets as a basis for force and logistics planning, operation analysis, development of weapons employment doctrine, and data for field literature.

Department of Defense Joint Modeling and Simulation System (JMASS)

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The Department of Defense (DoD) Joint Modeling and Simulation System (JMASS) will provide a common software architecture to develop and configure engineering/engagement models, execute simulations and post-process data. The architecture provides advantages of reuse, interoperability, and commonality for the DoD modeling, simulation, and analysis community as they support the various program managers in the weapons system acquisition process. The presentation will provide an overview of the architecture, shortfalls of existing modeling methods, advantages of DoD JMASS, its cost, and the development approach as it moves toward implementation.

Thursday, 0830-1000; MS&W WEIRD STUFF
Pursuing Techniques to Support the 21st Century Warrior

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Recent changes in the analytical processes within the Marine Corps stem from the realization that traditional simulations were incapable of representing many of the attributes of the world required to help explore contemporary military issues. In addition analysts have observed that advances in computer science and calculational capabilities could, if applied properly, provide data and insight for more appropriate abstractions which would be useful in addressing many military questions. The result is a regression to the World War II roots of operations research. Namely, it is the use of multi-disciplinary teams and the scientific method. We want to take a look at questions of interest to the Marine Corps from the perspective of many data points. Our meta-technique, which we call data farming, provides a framework to explore questions in this manner. In our presentation we use agent-based models and map fitness landscapes to illustrate how we are beginning to implement data-farming on three fronts to support maneuver warriors: improving models, enhancing interpretation of results, and enabling intuition.

Representing Human Response to Moving Ground Targets in Search and Target Acquisition Models

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The target acquisition model currently used by the Army modeling community predicts the probability of detection as a function of target size and contrast, and a calibration parameter, n50. This parameter, called the Johnson criterion, represents the number of resolvable cycles necessary for 50 percent of the observer population to accomplish the task (for example, detection of a stationary target). A standard n50 is used for stationary targets and a different n50 value is used for moving targets. The value of n50 for moving targets is assumed to be half the value of n50 for stationary targets.

In an effort to investigate the n50 used for detection of moving targets, a laboratory perception experiment was designed and analyzed by the US Army Material Systems Analysis Activity and conducted by the US Army Tank-Automotive Command at their perception laboratory facility in Warren, Michigan. Scientifically and statistically significant data were collected to gain insight into the factors and interactions that influence human observer detection of stationary and moving ground targets in realistic background scenes. This paper provides a discussion of the perception experiment and analysis of the data, compares the data to model outcomes and recommends an algorithm to more accurately model the detection of moving ground targets.

A History of Model Usage within the Army by a Practitioner of the Black Art of Simulation

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This presentation will cover model developments and usage within various corners of the Army (and some Joint implementations) from the unique perspective of one who served in the front line trenches of simulation. The survey will cover at least thirty years of models to include their numerous name changes to protect their identify if not their life. The emphasis will be high resolution non-interactive models with side discussions on aggregate and interactive models. Discussion will include influential personalities and their contribution. Do you know where the name CASTOREM originates? Do you know the background for Aggregate Level Simulation Protocol (ALSP)? Do you know who proposed that each service creates its own model and integrate them into a joint view of the world? A summary of lessons learned will be conclude along with a view of what the future could bring.

Alternate Presentations

Warfighting Analysis in a Ruck Sack (WARS)

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The US Army Concepts Analysis Agency has developed a warfighting analytical support team which has demonstrated the capability to provide a deployable, responsive, real time warfighting campaign analysis to the theater level commander in the field. This significant accomplishment is the result of combining several advancements in operations research techniques, decision analysis methods, state-of-the-art hardware and software developments packages. Utilized by US Central Command (CENTCOM) and US Army CENTCOM (ARCENT), WARS has been employed to conduct course of action assessments, determine force allocation and requirements, develop war plans and serve as an exercise 'driver'. During Desert Storm, such analysis was conducted using a mainframe and typically required 5 days to complete a course of action assessment. WARS enables the same task to be accomplished in 2-3 hours to include production of decision maker quality products. Lieutenant General (Retired) Steve Arnold, former Commander of ARCENT, describes WARS as "...truly revolutionary, significant and influential..." and "...this capability could and should soon be proliferated to corps and divisions." Clearly, WARS is an analytical quantum leap forward in leveraging today's technology and portends how technology can assist the theater level warfighting commander's campaign decision making.

Use of High Fidelity Combat Simulations to Support Research & Development Investment

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As basic and applied research and development resources have become more scarce, decision authorities seek better means to decide on which proposed approach will have the greatest potential of increasing the performance and survival of future military users. These decision makers seek rapid answers to their "what if" questions, without having to invest in the construction and extensive testing of prototype items.

During the last five years, the US Army Soldier Systems Command's Operations Research Analysts and their supporting contractors have applied high fidelity modeling and simulation applications to provide answers to Soldier System materiel developers with analyses to support their design and development decisions. The tools have been enhanced and applied to support examination of such issues as the positioning of ballistic protective material, the effects of soldier signature reduction, and the potential battlefield contribution of proposed precision air drop systems.

This paper provides a description of the main simulation tools used, discusses applying these tool, provides examples of some of the savings that have been recognized by using these tools, and suggests future applications of modeling & simulation tools to support future Department of Defense (DoD) research and development programs.

Thursday, 1330-1500 NEW MODEL INITIATIVES

Wargame 2000 Verification and Validation

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Wargame 2000, being developed by the Ballistic Missile Defense Organization (BMDO) at the Joint National Test Facility (JNTF), is intended to support warfighters in examining their CONOPs, doctrine, tactics, techniques, procedures, and plans for specified air and missile defense command and control infrastructures. Wargame is expected to have five modes (or kinds of application): 1) concept of operations (CONOPS) development (expected to be the most commonly used mode or application), 2) CINC assessment and field exercise, 3) staff and operator familiarization, 4) architecture assessment, and 5) test and evaluation (T&E) support. Wargame 2000 will be the replacement for ARGUS (Advanced Real-Time Gaming Universal Simulation), which has provided useful ballistic missile defense war gaming capability over the past decade. Verification and validation (V&V) of Wargame 2000 is a daunting task. This presentation will describe BMDO's V&V approach and will discuss issues related to V&V of a large human in control (HIC) air and missile defense command and control (C2) simulation.

Army Advanced Concepts and Requirements (ACR) Analytical Support

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Developing and preparing land forces for future military operations is a core competency of the institutional Army. In order to systematically develop future forces and operational capabilities, the Army relies heavily on the use of analytical modeling and simulation (M&S) tools. The very diverse and complex family of these Army M&S defines the ACR domain. It is important to recognize that M*S differ by type (constructive, virtual, live), by application supported (analysis, training, acquisition, resource allocation), and by scope and level of detail (long theater campaigns to small unit tactical combat). It is the principle focus of ACR domain processes to provide strategic direction, concept development, requirement determination, and force planning. ACR domain activities depend on insights and quantitative data from M&S for analyzing strategic, operational and tactical operations in war, conflict and operations other than war. The primary products of these activities are strategies, warfighting concepts, mission needs, doctrine, requirements, executable plans, and affordable programs. This presentation describes the current and future family of ACR simulations, simulation mission needs, and representative application of simulations to Army Force XXI Process.

USMC Joint Simulation System (JSIMS) Operational Testing Strategy

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The Marine Corps Operational Test and Evaluation Activity (MCOTEA) has been tasked to conduct Operational Testing (OT) of the Joint Simulation System (JSIMS). Major components of JSIMS include simulation objects, interfaces to real world C4I systems, and a simulation infrastructure based on the DMSO sponsored High Level Architecture (HLA). The USMC JSIMS OT strategy will employ a unique approach to conduct OT. The Marine Corps intends to develop a test plan that exploits concurrent Verification and Validation (V&V) and combined Development Testing (DT) and OT.

MCOTEA and the Marine Corps Systems Command (MARCORSYSCOM) have established a Memorandum of Agreement (MOA) for testing software intensive systems. Some of the items defined by the MOA include software metrics, requirements traceability, and risk assessment. JSIMS will be a software intensive system and will need to satisfy the metrics defined in the MOA. The USMC JSIMS OT strategy must also comply with the MOA. As part of the OT strategy, USMC JSIMS will be tested incrementally in several builds with concurrent DT/OT.

The JSIMS Test and Evaluation Master Plan (TEMP) states that testing results may be used to support V&V for cost savings. MCOTEA will monitor the V&V process to ensure that the JSIMS design matches Marine Corps requirements, the software implementation matches the JSIMS design, and that the final software implementation tracks back to the requirements. Three Collaborative Events (CEs) will be conducted to support combined DT/OT prior to IOC (FY00). The results of tests from each CE will be reported in an Independent Evaluation Report (IER). The IER will identify additional areas of concerns and risks which may be addressed in subsequent Software Integration Tests (SWIT) and System Tests for follow-on CEs. Thus, the USMC JSIMS OT Strategy will leverage off of concurrent V&V and the combined DT/OT Test Concept to achieve a thorough test, within current monetary and time constraints.

Alternate Presentations

Man-in-the-Loop Distributed Simulation and VV&V (...and things that go bump in the night!)

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Applying, Verification, Validation, and Accreditation (VV&A) to a distributed man-in-the-loop simulation effort is often viewed as a mystery, much like things that go bump in the night. When incidents occur at night, what happened at the moment is often obscured by the darkness, but the results always seem to be evident in the morning! And so it is with VV&A. Many simulation managers and engineers view VV&A as a dark mystery, much like things that go bump in the night, but still want to control their simulation efforts to ensure successful, meaningful results are always achieved in the morning. How do you do cost-effective VV&A? How thorough must it be? How much is enough? These are just a few of the common questions associated with VV&A, reflecting how little is known and how much is misunderstood.

This paper is about a specific VV&A effort in support of the Joint Combat Search and Rescue (JCSAR) Joint Test and Evaluation (JT&E) Virtual Simulation (VS) program. For VS-1, the Joint Test Force (JTF) connected three large simulation sites using a Distributed Interactive Simulation (DIS) network to analyze and characterize various Search and Rescue (SAR) issues. The author, the JCSAR JT&E VV&A Agent, discusses the VV&A approach needed to support VA-1 with an eye on the VV&A issues and methodology. Topics are discussed within the context of this real man-in-the loop simulation effort and the decisions that impacted the VA-1 simulation program. Successful JCSAR JT&E VV&A techniques such as facility documentation reviews and face validation by subject matter experts are discussed in detail as real examples of how to do VV&A within a limited budget. The goal of the paper is to unlock the secrets of how to ensure a distributed simulation is realistic and credible through the use of VV&A.

Conceptual Models of the Mission Space (CMMS): Basic Concepts, Advanced Techniques, and Pragmatic Examples

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Conceptual Models of the Mission Space (CMMS) are simulation implementation-independent functional descriptions of the real world processes, entities, and environment associated with a particular set of missions. In particular, CMMS is: 1.) A disciplined procedure by which the simulation developer is systematically informed about the real world problem to be synthesized. 2.) A set of information standards the simulation subject matter expert employs to communicate with and obtains feedback from the military operations subject matter expert. 3.) The real world, military operations basis for subsequent, simulation-specific analysis, design, and implementation, and eventually verification, validation, and accreditation/certification. 4.) A singular means for establishing re-use opportunities in the eventual simulation implementation by identifying commonality in the relevant real world activities. And 5.) A library of re-usable conceptual models for simulation development. This paper provides an introduction to basic CMMS concepts, a summary of advanced techniques, and a roadmap to a set of related conceptual modeling papers which provide a pragmatic "“end-to-end” example of the creation and usage of conceptual models in selected DoD modeling and simulation projects.

The Next Generation Mission Model (NGMM)

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The Modeling and Simulation Integration Office (MSIO) is the acquisition focal point for Air Force Materiel Command's (AFMC) Electronic Warfare (EW) and Modeling and Simulation (M&S) issues and covers activities from five aspects: product acquisition, depot logistics, test, R&D, and training. While each of these areas has active Integrated Product Teams (IPT), each area provides very different and unique perspectives to its EW and M&S users. MSIO's mission is to improve the success of EW systems and to facilitate integrated, distributed, open environments, and ensure coordinated M&S toolset development. This presentation will touch on a number of EW and M&S issues such as the AF M&S Resource Repository (AFMSRR), Common LO Verification System and Common Missile Warning System, Distributed Mission Training, EW Operational Support Study, Exploitation Data Interchange Partnership, threat model requirements, and new developments in acquisition, models, and data.

The presentation will focus specifically on the Air Force Materiel Command's Modeling and Simulation Integration Office (MSIO) activities involving the Next Generation Mission Model (NGMM), a multi-system, "raid-level" effectiveness modeling tool that supports all domains (e.g. space, air, and C4ISR) for acquisition analysis. The MSIO is leading the initial stages of a Concept Exploration phase for the NGMM, with the challenge to develop a draft set of requirements, a draft plan for an Analysis of Alternatives (AoA), and a draft acquisition plan. These activities, which will involve both Government and industry, will be discussed at the top-level.

WG 30 - REVOLUTION IN MILITARY AFFAIRS - AGENDA

Chair: Mr. Frank Papparozzi, ANSER
CoChair: Mr. Scott Orton, ANSER
CoChair: Mr. Phil Comstock
Room: ME-145

Tuesday 1030-1200
Measures of Effectiveness (MOEs) for the Army in the Information Age
Mr. Richard E. Darliek, RAND Arroyo Center

Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling
Alan D. Zimm, Senior Professional Staff, Johns Hopkins University Applied Physics Laboratory

Tuesday 1330-1500
Heuristic Military Analysis
Major Jon J. Peterson, Combat Operations Analyst, TRADOC Analysis Center

Breaking the Phalanx (BTP) Analysis
Wm. Forrest Crain, Colonel, Chief of Operational Capabilities Assessments
Steve Orloff, LTC, Senior Operations Research Analyst
U.S. Army Concepts Analysis Agency

Wednesday 0830-1000
The Necessity for Integrating Space Assets into Campaign Analysis
James R. Hunter, Capt, Chief, Detailed Campaign Analysis, Mark A. Powers, Capt, Chief, Space Utilization & Operations, SMC/XR, Systems Engineering & Integration Branch

Mission Area Assessment (Strategy to Task) Methodology for Modernization Planning
Chip Yarger, Civ, Don Olynick, Civ, Operations Research Analyst, ANSER Corporation

Wednesday 1030-1200
Exploiting Commercial Innovation In Space
Scott Orton & Chiang Ren, ANSER Corporation

Global Engagement 97
Kenneth E. Lavoie, Assoc. Director, Air Force Wargaming Institute and Dr. Daniel B. Fox, Senior Analyst, Rand Corp.

Wednesday 1330-1500
Strategic Planning for the Air Force Leveraging Commercial Practices
Deborah Westphal, SMC/XR, Richard Szafranski, TOFFLER ASSOCIATES and Dr. Gregory S. Parnell, TOFFLER ASSOCIATES and Virginia Commonwealth University

Incorporating Space Systems Into Wargames
Dr. Garret Schneider, Ms. Kathy Sadler, Dr. Steve Harrison, TASC

Thursday 0830-1000
Information Dominance: Balancing Art & Science
Mike Furlong, ANSER Corporation

Value Driven Measures of Merit for Offensive Information Operations
Captain Michael P. Doyle, Dr. Richard F. Deckro, Lt Col Jack A. Jackson, LTC Jack M. Kloeber, AFIT

Thursday, 1030 - 1200
COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday 1330-1500
On Linking C4ISR Improvements to Increases in Military Effectiveness
Charles R. Hall III, Senior Principal Analyst, The MITRE Corporation

Fundamentals of Wargaming
Lt Col Ramon Cortes, Maj Tim McIlhenny, Wargaming Branch, Air Force Studies and Analyses Agency

Room: ME-145

Tuesday 1030-1200

Measures of Effectiveness (MOEs) for the Army in the Information Age

Mr. Richard E. Darliek
RAND Arroyo Center
(202) 296-5000, ext. 5375

This presentation summarizes the results of a project undertaken for the Office of the Deputy Chief of Staff for Operations and Plans, U.S. Army Staff. The objective of the project was to help the Army identify new measures of effectiveness (MOEs) that capture the improved effectiveness predicted to accrue to ground forces as they exploit information-age technologies in the 21st century. In initiating the project, the sponsor was motivated, in part, by a concern that the Army is about to spend a substantial portion of its procurement budget on information-age linkages across its forces (e.g., the digitization of Army XXI). In the future, potential adversaries will probably make similar investments, while the U.S. Army will advance still farther into the information-age (e.g., with the Army After Next).

None of these expenditures may change the basic force components – units and weaponry – that are currently used by both intelligence analysts and military modelers to measure force effectiveness. Technological advances, however, such as new C4ISR systems and "internetting" across units, may produce major, even revolutionary improvements in force effectiveness that will not even register in traditional "industrial-age" models of battle. Because traditional MOEs remain grounded in attrition models that calculate effectiveness on the basis of exchange ratios dominated by major weapon platforms, they measure only a portion of the capabilities a force is expected to bring to battle in the information age. Moreover, traditional MOEs already fall short when it comes to addressing other military operations, formerly called operations other than war, which could tend to predominate in the future.

New assessment yardsticks will be required to measure and refine "information-age" improvements in our own forces, as well as to measure the effectiveness of threat forces, since adversaries are also likely to invest in the new technologies. New MOEs could help guide the Army's search for the best technological applications and help assess applications already under development. In the absence of MOEs that measure the presumed benefits of information-age technologies – "information superiority" and "dominant maneuver," to name two – the Army's ability to guide and justify its own expenditures, as well as to measure the real power of likely adversaries, will suffer.

This presentation helps develop a preliminary set of MOEs for the information-age Army in several ways. It examines the continuing relevance and application of Lanchester's "square" law to combat in that era and suggests that, in theory and over time, Lanchester's "linear" law (for example) might become more relevant for future ground combat if the Revolution in Military Affairs (RMA) and the Army's information-age capabilities mature as predicted. The presentation also employs a game-theoretic simulation to help define various levels of information-superiority the Army could seek to achieve in the 21st century, as well as the potential implications of each level. The work postulates an initial set of MOEs for ground combat addressed to the operational concepts presented in Joint Vision 2010: dominant maneuver, precision engagement, full dimensional protection, and focused logistics. Finally, the presentation concludes with another preliminary set of MOEs, likewise organized in accordance with Joint Vision 2010's operational concepts but addressed this time to other military operations conducted by the Army in the information age.

Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling

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Most current models of combat are based on an attrition warfare paradigm, where destruction of enemy forces and material are the objectives. However, models based on attrition warfare approaches do not reflect the actual combat processes that lead to victory. The current U.S. Marine Corps doctrine of Maneuver Warfare recognizes that the path to victory lies in more than destruction of material - for example, Marine Corps Doctrine Publication -1, "Warfighting," says that "the results of maneuver are both physical and morale. The object of maneuver is to shatter the enemy's cohesion, organization, command, and psychological balance." Clearly, any model that does not incorporate "cohesion, organization, command, and psychological balance" cannot reflect the relative strengths and weaknesses of Maneuver Warfare.

A serious handicap has been the lack of a conceptual model of Maneuver Warfare on a level that could be incorporated into computer simulations.

This presentation outlines a conceptual model of Maneuver Warfare. The scope of the model runs from non-combat "deterrence" operations through combat in major wars. It incorporates defining and modeling the sources of victory, incorporates human factors such as morale, cohesion, and fighting spirit, and creates a conceptual model of the degradation of command processes when under stress. The objective is to provide a common taxonomy, define interrelationships, and serve as a springboard towards a more detailed algorithmic-level development of a model of Maneuver Warfare.

Tuesday 1330-1500

Heuristic Military Analysis

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Heuristic Military Analysis, executed through analysts and Subject Matter Experts (SMEs), can be used to provide credible, accurate analysis when faced with predominantly qualitative data. During the Force XXI Division Advanced Warfighting Experiment, (DAWE) one of the key products desired was an insight on how the modern systems and Force XXI employment concepts facilitated or otherwise affected the somewhat intangible entity of Battle Command. Heuristic Military Analysis, as an exploratory problem solving technique, was used to investigate selected operations conducted during the DAWE to identify and highlight demonstrated and potential Force XXI capabilities. The methodology included collecting data and insights from the Battle Command Training Program (BCTP) observers, system SMEs, Player unit, and analysis team members to develop a comprehensive understanding of the events within those operations. From! this understanding, challenges, capabilities, and potential to execute missions through the Force XXI Patterns of Operations were identified. These challenges, capabilities and potential capabilities, were then translated into DTLOMS implications. Heuristic analysis of the qualitative data provided by the Subject Matter Experts as described produced insights on the ability of the commander to wield these systems and concepts, and suggests areas for future refinement.

Breaking the Phalanx (BTP) Analysis

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The BTP Analysis was conducted at the request of the Chief of Staff of the Army, and is an examination of the organizational, modernization and doctrinal initiatives for the Army proposed by COL Doug MacGregor in his book *Breaking the Phalanx.*

The analysis departs from the standard "cold war attrition modeling" paradigm and examines the initiatives in light of the physical, mental and moral domains of war in a Southwest Asia MTW scenario. The contribution of each initiative, as well as in combination with the other initiatives, is considered to identify any synergistic benefit which might be realized. The organizational initiative considers the current US Army division structure versus that of brigade sized groups. The modernization initiative considers the Force XXI capabilities versus those programmed for the 2005 time frame. The doctrinal initiative examines current warfighting doctrine versus one which is designed to capitalize on the Force XXI capabilities (described in TRADOC Pam 525-5).

The results provide interesting insights into which of these initiatives provide the most significant benefit to the warfight and which ones, in combination, offer the greatest potential to force effectiveness. Of particular interest in this analysis is how the capability of information dominance and situational awareness were introduced into the simulation.

Wednesday 0830-1000

The Necessity for Integrating Space Assets into Campaign Analysis

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Abstract: Force structure decisions that leadership is making will involve trades between ground, air and space systems. These trades are made with tools that inadequately show the impacts of space systems, and, as such, could lead to decisions with inadequate results. We in the modeling, simulation, & analysis (MS&A) community must take a hard look at the design and implementation of the current and future underlying model infrastructures supporting space assets. More importantly, the effects of these platforms must be consciously taken into account when determining whether to emulate or directly simulate the ensuing services they bring to the warfighter. Such platforms as GPS, SBIRS, or MILSATCOM are providing valuable information to the theater commander and JFACC but the impacts of these systems are not being adequately simulated in current models. Also, future space assets must be kept in mind or we will return to the current dilemma of reinventing space infrastructure in campaign modeling. This paper will try to illuminate the issues needed for comprehensive campaign model modifications and provide guidance for integrating the lessons learned into tomorrow's models. Both the presently accepted method of modeling which looks at the entire campaign and at a newer method of campaign analysis involving the Quick Reaction Analysis developed by Rand which only looks at a slice of the campaign given certain assumptions will be explored.

Mission Area Assessment (Strategy to Task) Methodology for Modernization Planning

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Air Force MAJCOMs conduct modernization planning in three-steps: (1) Mission Area Assessment (MAA) defines the operational tasks within a specific mission; (2) Mission Needs Analysis (MNA) assesses current and programmed USAF capabilities to conduct the MAA defined tasks; (3) Mission Solutions Analysis (MSA) explores both materiel and non-materiel solutions to MNA identified deficiencies in the ability to conduct MAA defined tasks. The final output is a set of concepts that would ensure accomplishment of all future tasks. However, since not all concepts can be funded due to a limited budget, the planner is faced with the decision of what concepts to select to receive the most "bang for the buck".

This paper describes a new approach to the modernization planning process to optimize the set of concepts selected. This new methodology involves defining operational tasks as parts of the OODA (Observe – Orient – Decide – Act) Loop to do several things; define customers, suppliers, future tasks, and measures of effectiveness; translating requirements into military utility; scoring each concept on how well it accomplishes assigned tasks; and finally, inputting this information into a mixed integer program to derive an optimized solution set of concepts. Benefits to this process are that it focuses attention on customers, emphasizes the degree of mission task accomplishment (vs satisfying mission deficiencies), and uses an optimization model to derive the best mix of concepts to accomplish assigned tasks. This process is presented as a work in progress and will include any available results from the current 1998 iteration.

Wednesday 1030-1200

Exploiting Commercial Innovation In Space

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The guiding vision of the Air Force, Global Engagement, has specified that the Air Force is transitioning to an Air & Space Force on an evolutionary path to a Space & Air Force.

The current and future environment for fulfilling this vision is one of increasingly constrained defense spending with a rapidly maturing commercial presence in space. The post-Cold War security environment is becoming ever more complex with smaller but more diverse threats emerging from regional instability and the massive global proliferation of military technology. Thus, the transition and evolution of the Air Force towards a Space & Air Force will require innovative exploitation of limited resources to continuously optimize capabilities in space.

The exploitation of the new commercial space culture may be the critical leverage for the Air Force to grow capabilities and increase investments in militarily unique areas. The challenge, however, is that the Air Force may have to undergo an immense culture change from one in which identified material deficiencies automatically push for milestone decision and system development to one of first considering buying space capabilities as a service from the commercial market with no Air Force involvement in the systems. Launch, communications, and imagery can all be treated as purchasable commodities. This presentation will expand upon this new way of doing business for the Air Force.

Global Engagement 97

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The Global Engagement wargame series was established by the Chief of Staff of the Air Force as an integral part of the service's long range planning process. The games are designed to provide joint warfighters with the opportunity to challenge emergent concepts, ideas, and assumptions. Global Engagement '97 was set in northeast Asia in 2012 with a specific focus upon: space, information operations, mobility, and logistics. The game involved three parallel seminars independently examining the issues, supported by three suites of nine somewhat disparate models. This presentation will summarize the scenario, game design concept, model supported adjudication process, special focus area insights, and some of the operational-strategic level insights of game play.

Wednesday 1330-1500

Strategic Planning for the Air Force Leveraging Commercial Practices

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Recently, the corporate Air Force reviewed its core values and core purpose in order to produce a guiding vision entitled *Global Engagement.* The goal being to ensure the Air Force possesses the air and space power necessary for America's defense in an uncertain time. Using the vision, the Air Force created a systematic, institutionalized long-range planning process to both identify the capabilities necessary for future warfighting and allocate the resources required to enable the vision.

A closer examination of the methodology used in this planning process is warranted. Is it too restrictive to allow for flexibility, institutional agility, and the rapid responsiveness required to meet the often unpredictable demands of an uncertain future? Will it support a Revolution in Military Affairs? Does it allow for the discontinuous technology explosions that can rapidly and radically alter the strategic landscape and can neither be predicted nor forecast?

The answer may lie in the differences between strategic awareness and planning. In the business world, companies that enjoy enduring success have core values and a core purpose that remain fixed while their business strategies and practices repeatedly adapt to changing environments. This paper will attempt to explore different methodologies used in the business world for developing business strategies under conditions of uncertainty and rapid change in order to highlight those that may apply to the Air Force planning process.

Incorporating Space Systems Into Wargames

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There have been a host of recent wargames in which space systems and services have received a great deal of attention - either due to their impact or because these hypothetical exercises have escalated into space "wars". These games include the Army After Next series, the Navy's Global '97, and the Air Force's Global Engagement. Of particular rising concern is how the loss of services provided by space systems, or the loss of the assets themselves, become quantified and incorporated in the game play to accurately influence decisions, actions and events. The influence of space spans political, strategic, operational and tactical considerations. First attempts have been to use expert opinion (supplemented by specialized space-oriented computer modeling) and ensure that ensuing game moves are appropriately affected. A major shortcoming of this has been a lack of understanding on the part of game players and directors of the causal relationship between space systems/services and terrestrial events. The space community is attempting to find ways to better quantify space's contributions to military operations - through models and analytical tools - and incorporate them in familiar computer models such as THUNDER, ITEM, and EADSIM. This will lead not only to better understanding but also to more accurate game play, more thorough analysis of options, and better-informed decisions by senior game players.

Thursday 0830-1000

Information Dominance: Balancing Art & Science

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Although the Information Operations/Information Warfare functions are becoming more institutionalized within Department of Defense, there is still a proclivity towards defining too narrowly the concept of "Information Superiority". Current definitions are heavily weighted towards a "sensor-to-shooter" systems concept. The recent Iraqi crisis (October '97 and January-February '98) has reinforced the concept that information operations is much broader than just network-centric activities or "dueling computers".

Much of the recent adversarial competition between the US Government and Saddam Hussein was a psychological battle involving the so-called "softer" information warfare tools (i.e., public information, psychological operations, public diplomacy, covert activities, operational security and deception). Perception Management (for lack of a better label) captures this notion of the "softer" information warfare tools.

The Iraqi crisis has also vividly demonstrated that successful Information Warfare is dependent upon information dominance. Dominance over the adversary in detecting hostile activities, collecting, analyzing, and fusing information, and quickly distributing information to decision-makers and users for ultimate action. Losing the TV media (public perception) aspect of information operations is just as damaging to the US Government mission as having our computer networks penetrated with "viruses".

As we saw with the Haiti crisis in '94, and again recently with Iraq, Perception Management is critically important to building domestic support at home, allied support for international political/military coalitions, and political isolation of the adversary in the UN. Perception Management is most importantly, about preventing conflict. Perception Management also helps shape the operational environment for future military operations, if required.

Once hostilities have begun, the utility of the technical "sensor-to-shooter" systems reaches a zenith--and is most importantly about winning in the battlespace. The art of information operations/warfare is in achieving the appropriate balance between employment of the human factors oriented "soft" information tools and the more technical network-centric tools.

Value Driven Measures of Merit for Offensive Information Operations

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Measures of merit for offensive information operations (IO) have been developed using value-focused thinking. By first identifying and structuring the valuable attributes of the information realm into a hierarchy, objectives for offensive IO are developed that target each valuable attribute. For each of these objectives, measures are identified that enable the assessment of the level of attainment for each objective. The return-to-scale for each measure is assessed using operational decision maker preferences. Scenario-based weighting of the offensive IO objectives is then used to score operational systems currently in the US arsenal. These systems are then ranked on single point measures and using multiple measures(all based on the values of operational decision makers. This analysis not only permits value-driven system selection, but also provides a means to identify opportunities for weapon system development and acquisition.

Thursday 1030-1200

COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday 1330-1500

On Linking C4ISR Improvements to Increases in Military Effectiveness

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This presentation is a response to those who continue to argue that they have no way to measure the contribution of C4ISR systems to military effectiveness and attempt to solve this deficiency by searching for new measures of effectiveness specific to C4ISR systems. The presentation describes an approach (The Recipe) for conducting benefits analyses for C4ISR systems using standard measures of effectiveness, that is, measures related to the commander's objectives. The recipe presented is simple in description but not necessarily easy in execution. Nevertheless, it is workable and has been employed successfully in the real world of DoD acquisitions. The presentation provides some background to set the stage and then offers a well-defined approach or recipe for dealing with C4ISR systems (Systems That Don't Shoot). This approach is then illustrated by an example from a DoD COEA conducted several years ago which was well-received by its audiences. It should be noted that portions of the presentation were presented as a tutorial at the 64th MORS at Fort Leavenworth. The current presentation goes deeper into the specifics of the method and attempts to provide a better understanding of the effort necessary for successful execution.

Fundamentals of Wargaming

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Fundamentals of Wargaming is a wargaming primer that discusses the basics of military wargaming. This primer is an educational tool. The primer provides a clear definition of what a wargame is and what it is not and it explains wargaming strengths and weaknesses. This primer examines the uses of wargaming in DoD and the Air Force. Finally, the primer discusses the dangers and misuses of wargaming.

WG31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH

Chair: Major William S. Murphy, Jr., TRADOC Analysis Center - Monterey
Co-chair: Captain Jeffrey L. Huisingh, TRADOC Analysis Center - Monterey
Co-chair: Mrs. Pamela J. Blechinger, TRADOC Analysis Center - Monterey
Co-chair: Lieutenant Colonel Robert Kilmer, US Army War College
Co-chair: Ms. Cathy J. Corley, TRAC - Operations Directorate
Advisor: Dr. J. Ralph Wood – Raytheon Systems Company
Room: ME-150

Tuesday, 1030-1200
The Army Flow Model
MAJ Bob Phelan, US Army Artificial Intelligence Center

Assessing the Robustness of Neural Networks on the Classification of Terrain Features
LTC Jack Marin, Ph.D., Associate Professor, U.S. Army, United States Military Academy

In Pursuit of M&S Standards
Ms. Lana McGlynn, US Army Model and Simulation Office

Tuesday, 1330-1500
JWARS Contribution to the DOD's Conceptual Model of the Mission Space
Frederick Weaver, Jr., Principal Analyst, GRCI

C4I Analysis Across A DIS Network
CAPT Dave Smith, DET 4, 505 CCEG (TACCSF)

Data Collection and Analysis Tool - Near Real-time Feedback from Distributed Experiments
Neal T. Lovell, Senior Manager, Quality Research Incorporated

Wednesday, 0830-1000
Designing and Developing a Divisional Operational Analysis Tool Package
CPT Blane Wilson, Department of Operational Sciences

Mission Space Model Development, Reuse and the Conceptual Models of the Mission Space Toolset
Thomas H. Johnson, Innovative Management Concepts, Inc.

A General Purpose Solution for Analysis in the High Level Architecture (HLA)
MAJ William S. Murphy, Jr., US Army TRADOC Analysis Center-Monterey

Wednesday, 1030-1200
Computational Adjustments of "Incorrect" Priors
CPT John Moellering, Jr.

A-Life Technology Based Analysis and Design Optimization
M. E. Senglaub, PhD, SMTS

Using Intranets in Strategic Wargames
Robert Kilmer, LTC, Director, Knowledge Engineering Group

Wednesday, 1330-1500
A Graph and Network Component for a Loosely Coupled Planning System
Leroy A. Jackson, Major USA, Operations Research Analyst US Army TRADOC Analysis Center--Monterey

Use of High Fidelity Combat Simulations to Support Research & Development Investment
John A. O'Keefe IV, Senior Operations Analyst, US Army Soldier and Chemical/Biological Command (PROV)

How Fast is Fast Enough? (A Communications Network Study)
Howard P. Haeker, Director, Joint Virtual Laboratory (JVL), TRADOC Analysis Center

Thursday, 0830-1000
Solving the Generalized Assignment Problem Using Explicit-Constraint Branching
Jeffrey A. Appleget, LTC, Department of Mathematical Sciences, United States Military Academy

An Efficient Algorithm for Calculating Shortest Paths while Avoiding Obstacles
Emmet R. Beeker, Senior Analyst, GRC International

Redesign of ATCAL Attrition Algorithm for Military OR Problems in the Twenty-First Century
James G. Taylor, Operations Research Department, Naval Postgraduate School

Thursday, 1030 - 1200
COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday, 1330 -1500
Line of Sight and Perspective View Server for Windows NT
Wolfgang Baer, Assistant Professor of Computer Science, Naval Postgraduate School

Achieving platform independence for network communications and user interfaces accessing the Generic Data System
David J. Ward, Student, California State University Monterey Bay

C-17 Airlift Loading Model Using Java
Chris Chocolaad, 1[st]Lt, USAF, Air Force Institute of Technology

WG31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH - Alternates

Modeling Using Dynamic Network Algorithms
Lawrence G. Fess, Electronic Engineer, Joint Warfare Analysis Center

Verification, Validation and Certification Process and Automated Tools
CPT Byron B. Tatsumi, Chief, Data Applications Branch, Air Force Studies and Analyses Agency

WG31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH – Abstract
Room: ME-150

Tuesday, 1030-1300
The Army Flow Model

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The Army Flow Model, currently under development by the U.S. Army Artificial Intelligence Center, was conceived to provide a system to support the Chief of Staff and Vice Chief of Staff of the Army (CSA/VCSA) in decision making. It is a tool that allows the Senior Leadership of the Army to see the impact of policy decisions, in the context of actual or conjectured scenarios and resource constraints, across key functional areas of the Army. The key functional areas are: logistics, personnel, infrastructure, force structure, and budgeting (both dollars and training factors). The Army Flow Model will assist in making decisions from an integrated Army perspective instead of a purely functional perspective. The model displays the status and capability of the Army over time from the current year through the last year of the POM, thus allowing the senior leadership to focus on the actions and policies that may cause divergence from the desired end-state. It will also explain the causes and tradeoffs in decisions that are predicted to cause detrimental impacts in readiness and capability of the total force and provide policy rationale to external groups (i.e., Congress, DOD, etc.), the Army Staff, and MACOMs.

This paper presents an overview of the Army Flow Model and its integration into the staff processes of HQDA. It describes some of the issues/ challenges in developing an Army-wide staff analysis system. It also describes production support that the Army Flow Model provided to the Army Saff for the Total Army Analysis 05 as well as other major analytical efforts requiring cross-functional integration.

Assessing the Robustness of Neural Networks on the Classification of Terrain Features

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Terrain analysis is presently a heuristic art involving many intuitive, subjective judgments that can be difficult to precisely explain, but must eventually be addressed by automated reasoning systems if commanders are going to fully utilize the ever-increasing amounts of available terrain imagery. Several studies attest to the capability of neural networks to outperform traditional classification methods for feature extraction and classification. However, to attain this increased classification accuracy, a price must be paid. Neural networks require larger training sets than traditional methods, and are computationally intensive which means neural networks are notoriously slow. Drawbacks associated with neural networks would be mitigated if a trained network built for one dataset could be used to successfully classify a neighboring area. Similarly, a trained neural network would be more valuable if it could be used at a later time and date to classify new images of the same location. Preliminary results comparing the classification of multispectral and hyperspectral images using neural networks to manual (parametric) procedures are presented and discussed. This type of test for robustness and generalization of neural networks has not been previously reported in the literature.

In Pursuit of M&S Standards

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Standards Development within the Army's M&S processes is a vital step toward achieving the economies, efficiencies and technological potential M&S represents. Through standards, the Army's M&S community shares techniques, procedures, processes, and applications. It builds on t he work of others and advances the art and science of M&S in tandem with technological advances. Thus standards development is an iterative and consensus based process. This ongoing process consists of 18 standards categories which directly support achievement of the Department of Defense M&S objectives.

Tuesday, 1330-1500

JWARS Contribution to the DOD's Conceptual Model of the Mission Space

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In May 1995, the Deputy Secretary of Defense directed the establishment of the Joint Analytic Model Improvement Program (JAMIP) to improve DOD's ability to conduct theater-level, joint analysis. The Joint Warfare System (JWARS) project emerged as the long-term solution to this requirement. The foundation for the JWARS effort is a conceptual model of the mission space (CMMS). The JWARS CMMS is a detailed process model of tasks, events, conditions, actions, and interactions. A joint team of functional, data and object analysts, software engineers, and government subject matter experts captures this knowledge.

As part of the DoD Model and Simulation (M&S) Master Plan, The Defense Modeling and Simulation Office was directed to development a M&S Common Technical Framework to enhance interoperability and reuse of models, integrate information from independent knowledge acquisition sources, and identify authoritative sources of information. Once this information was collected it would be stored in a CMMS repository for use by the M&S community. JWARS is the first model to have its CMMS stored in this repository.

The purpose of this paper is: (1) Describe the knowledge acquisition process and how JWARS creates its CMMS. (2) Describe how this information is graphically represented within a CASE tool. (3) Explain how the CMMS takes information from JWARS and other models and stores in the central library. (4) Explain where the M&S community can obtain CMMS information to use in developing new models or enhancing existing ones.

C4I Analysis Across A DIS Network

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Many programs have successfully integrated Joint distributed simulations and real systems using DIS protocols to provide effective simulation of the Joint Warfare environment. Few programs have been able to fully analyze the events that occurred during these exercises or experiments. The Tactical Air Command and Control Simulation Facility (TACCSF) has established a simulation and data collection methodology, architecture, and analytical tool set capable of computing a robust set of C4I MOE/MOP for tests conducted on a DIS network linking virtual, and constructive simulations in a Joint virtual battle space. No new DIS PDUs or additional bandwidth during test execution is required. Each distributed site captures the required data from its simulations or systems during realtime and then does a simple reformat and transmits the data across the T1 to other sites. The data files from distributed sites are then merged in a MS Access relational database to

generate a combined Trial Event History for analysis. Examples of key queries used for coordinate and time transformations will be shown. In addition a flow chart of the complex queries which merge truth location and identity information from DIS Entity State PDUs with the appropriate recorded TADIL messages (perceived information) will be discussed.

This presentation will cover the current state of TACCSF's ability to provide accurate and timely data collection on critical operational events to facilitate analysis of performance and effectiveness of Joint operational concepts or C4I systems being tested across a DIS network. Operational performance measures will be addressed from the perspective of an air and missile defense analyst.

Data Collection and Analysis Tool - Near Real-time Feedback from Distributed Experiments

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DCAT version 1.0 is a near real-time data collection and analysis tool for Distributed Interactive Simulation (DIS) exercises. The tool allows the user to specify key information desired from an exercise (Measures of Effectiveness) and display that information in an easy to read graphic format. DCAT version 1.0 is available for Silicon Graphics Incorporated (SGI) systems running IRIX 6.2 with C++ compiler version 7.0 and Digital Equipment Corporation (DEC) Alpha systems running OSF 4.0 with C++ compiler version 3.2. DCAT is capable of running in three modes:

- Standalone – single CPU machine
- Client-Server – two single CPU machines
- Multiple Processor – two CPU machine

A full explanation of the capabilities of the tool and how it was developed will precede a demonstration of those capabilities. A number of examples will be used to demonstrate the utility of the tool for exercise control, feedback, verification, and analysis. Finally, future development plans for the tool will be explored.

Wednesday, 0830-1000

Designing and Developing a Divisional Operational Analysis Tool Package

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At the Army Division Level, there is a great potential to utilize operational research techniques to solve specific problems in areas such as maintenance operations, scheduling of training resources, simulation of spare parts, management of marshalling areas, queing systems for air loading, resource allocations, and resource projections. Presently, the personnel at the Division level do not have quick access to analysis tools, or they may not be knowledgeable in applying those tools and analyzing the results. The DUSA (OR) is sponsoring a study which would survey the Divisions for high payoff problems that Military OR would help solve within the division by division staff. The preliminary design of a division software package will be presented as well as the results of the survey.

Mission Space Model Development, Reuse and the Conceptual Models of the Mission Space Toolset

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The Conceptual Models of the Mission Space (CMMS) is a DoD Defense Modeling and Simulation Office (DMSO) Project aimed at; enhancing the interoperability and reuse of models and simulations by accessing descriptions of real-world operational entitles, their actions and interactions; identifying authoritative sources of information; integrating information from independent knowledge acquisition sources; developing and maintaining management processes; coordinating the presentation of modeling and simulation knowledge, and; establishing a broadly applicable set of CMMS resources and tools. This presentation will introduce a series of CMMS tools and their applicability for the development on Mission Space Models (MSMs). Examples of the use of these tools is demonstrated in the development of a National Air and Space Model (NASM) Air Interdiction Model.

A General Purpose Solution for Analysis in the High Level Architecture (HLA)

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The High Level Architecture (HLA) implements point to point network communications protocols and imposes publishing and subscription requirements on the objects, interactions, parameters, and attributes that are passed among federates within a federation. These factors constrain the manner in which an analyst is able to collect and ultimately analyze data in the HLA. Historical Distributed Interactive Simulation (DIS) data logging and post-processing schemes are impractical analysis solutions within this set of constraints, and would violate HLA principles if implemented. A HLA compatible Analysis Federate was developed to fill this void by delivering a general purpose tool that is designed to be used with any federation to perform real time and post processing analysis.

This presentation will discuss the system designed to the Analysis Federate. It will demonstrate the ability of the Analysis Federate to perform real time analysis on HLA object data that is generated by two Janus models which are fighting a constructive battle through the use of the HLA Gateway and the Protocol Data Unit (PDU) Adapter Software (PAS). It will also discuss the corresponding techniques and procedures that were developed to guide analysts who are working with HLA compatible models and simulations.

The applicability of the general purpose prototype Analysis Federate is to all live, virtual constructive, and Synthetic Theater of War (STOW) federations across all Army domains: Advanced Concepts and Requirements (ACR), Research Development and Acquisition (RDA), and Training, Exercises and Military Operations (TEMO). It is extendable for use in Joint Modeling and simulation HLA applications.

Wednesday, 1030-1200
Computational Adjustments of "Incorrect" Priors

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We consider situations where a tactical commander's uncertainty about the state of his adversary can be modeled by probability distributions over the set of possible states. We have modeled information gained by the commander, as a result of receiving scouting or reconnaissance data, in terms of the pre- to post-data decrease in Shannon's entropy of the prior and posterior distributions. Generally, information gain is positive (entropy decreases) through receipt of data, as one would expect. An exception arises when the commander is "very sure and very wrong." In this case, data received generally drives a low-entropy (sure) prior toward a more uniform (unsure) posterior, so computed information gain with the data is, at least initially, negative. One interpretation of this is that the low-entropy prior has not been formed correctly, as subsequent data corroborates. In some situations, such as combat simulations or operations at the National Training Center, simulation controllers can determine a realistic prior that "reasonable" commanders should prefer. We consider the problem of computing a "compromise" prior that gives appropriate entropy penalty to a commander's poor choice of prior. One approach is to determine a combined prior that is a maximum entropy mixture of the commander's and controllers' priors. We also discuss approaches involving considerations of terrain and "proximity" and present computational issues involved. Finally, we suggest applications of these ideas to modeling effects of deception.

A-Life Technology Based Analysis and Design Optimization

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Strategic analysts must tackle the difficult problem of assessing the performance of systems or the outcome of events that possess high degrees of non-linearity, uncertainty, and ambiguity. Traditional deterministic approaches tend to approximate these effects. In an effort to identify strategic system requirements, algorithms are being developed that can explore the parameter space associated with strategic issues and to mitigate traditional approximations. The emerging algorithms employ search and optimization techniques associated with Artificial Life (A-Life) technologies, including genetic algorithms, evolutionary strategies, and genetic programming. Fuzzy logic concepts are being assessed as a technology for the capture of tactical decision criteria. Fitness functions associated with the weapon system allocation problem including mission performance, inventory, collateral damage, time urgency, and target importance. Currently, target importance and time urgency is

represented by fuzzy logic concepts. The remaining fitness components are represented by approximately defined algebraic correlations. The plurality of technologies was driven by the strengths of individual techniques and the analytical demands of various aspects of the problem. The scale of the problem space is requiring concurrent development of algorithms for execution on massively parallel and sequential computational platforms.

In this briefing the hybridization of multi-level optimizations, fuzzy logic and classical algebraic decision or fitness correlations are defined and evaluated. The strengths of the different optimization technologies are examined to justify the extra coding effort required to use multiple techniques in strategic optimization problems.

Using Intranets in Strategic Wargames

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Wargames used to examine future concepts or to conduct training require access to large amount of static and dynamic information. For the past two years the United States Army War College has used Intranets to facilitate the flow of information to the participants, observers and controllers of wargames.

The purpose of this presentation is to discuss two of the Intranets used at the Army War College. The first Intranet was used to support the College's capstone Strategic Crisis Exercise for the past two years. Improvements to SCE Intranet included improved organization of information, the automated posting of Master Sceneario Events List (MSELs) and interfacing with databases to improve updating the dynamic portions of the Intranet during the exercise. The presentation will include a demonstration of the SCE Intranet. The second Intranet was used to support a year long distibuted advanced course among all of the Senior Service Colleges and a follow-on war game conducted at the Air War College.

Advantages, disadvantages and lessons learned about the creation and use of these Intranets will be discussed as well as recommendations for those interested in pursuing the use of this technology for wargames.

Wednesday, 1330-1500
A Graph and Network Component for a Loosely Coupled Planning System

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Military planning systems must evolve to meet the challenges of conducting military operations in the information age. The Department of Defense Joint Vision 2010 and the Air Force New World Vistas suggest the next generation of military planning systems will accelerate the tempo of analysis, operate over computer networks and on different computer platforms, and incorporate simulation technology for mission planning. Even the best-integrated planning tools today do not provide adequate interoperability, platform independence, or extensibility. Future planning systems must address new situations and needs of decision-makers that designers have not yet anticipated. These planning systems will feature an open architecture enabling new functions and capabilities to be added without disruption.

Incorporating graph and network models, and associated algorithms, into a dynamic military planning system has great potential for overcoming the shortcomings noted above. Traditional uses of graph and network models include planning, optimization, and simulation. Graph and network models, implemented in a loosely coupled dynamic planning system through a set of Java interfaces may provide the flexibility and adaptability needed in military planning and decision-making systems of the future.

This presentation describes work to design and implement an extensible Java library of graph and network algorithms for military planning in dynamic, distributed systems.

Use of High Fidelity Combat Simulations to Support Research & Development Investment

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As basic and applied research and development resources have become more scarce, decision authorities seek better means to decide on which proposed approach will have the greatest potential of increasing the performance and survival of future military users. These decision makers seek rapid answers to their "what if" questions, without having to invest in the construction and extensive testing of prototype items.

During the last five years, the US Army Soldier Systems Command's Operations Research Analysts and their supporting contractors have applied high fidelity modeling and simulation applications to provide answers to Soldier System materiel developers with analyses to support their design and development decisions. The tools have been enhanced and applied to support examination of such issues as the positioning of ballistic protective material, the effects of soldier signature reduction, and the potential battlefield contribution of proposed

precision air drop systems.

This paper provides a description of the main simulation tools used, discusses applying these tools, provides examples of some of the savings that have been recognized by using these tools, and suggests future applications of modeling & simulation tools to support future Department of Defense (DoD) research and development programs.

How Fast is Fast Enough? (A Communications Network Study)

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One of the main premises for Advanced Distributed Simulations (ADS) and the High Level Architecture (HLA) is that a communication network will be available which will meet the desired usage requirements.

This TRADOC Network Requirements paper provides a description of forecasted unique usage requirements based on current trends and technological advances; determines the forecasted network, bandwidth needed (based on OPNET) simulation runs with sensitivity of analyses); provides a description of candidate network alternatives and their capabilities, unique services and planned upgrades and estimated costs; and makes assessments of the degree to which each candidate network fulfills the forecasted usage requirements.

In addition the study provides the potential areas for integration, cost avoidance and standardization and recommended course of action for migration to potential network solutions for TRADOC for the year 1999 to 2005.

Thursday, 0830-1000

Solving the Generalized Assignment Problem Using Explicit-Constraint Branching

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The Generalized Assignment Problem (GAP) is a Binary Integer Programming model that can be used to model problems with Army and Joint application. Such applications include the scheduling of scarce resources to accomplish a mission, such as the deployment by sea of the equipment of CONUS-based units to Desert Storm, and scheduling the intra-theater delivery of scarce logistics such as fuel or ammunition. Because even modest-sized GAPs (200 variables) can be difficult to in a reasonable amount of computing time, enhanced solution techniques are required. This paper introduces explicit-constraint branching has also been used with success on other Ips and MIPs.

An Efficient Algorithm for Calculating Shortest Paths while Avoiding Obstacles

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We present an efficient algorithm to calculate route distances for transportation models. This algorithm uses Voronoi diagrams, and their dual, Delaunay triangulation, to build shortest paths on the Earth's surface while avoiding obstacles defined by closed sets of points (polygons). While Voronoi diagrams were introduced in 1850, it is only within the last fifteen years that efficient algorithms have been developed to produce and use them. The algorithm we show is efficient enough to be used within models to build shortest routes from arbitrary positions at sea to any (or all) ports, avoiding land and utilizing canals. It can also be used for air routing around restricted areas, no-fly zones, and hazardous weather. It is being implemented in the Intertheater Mobility Analysis Component (IMAC) of the Joint Warfare System (JWARS) to replace the SAIL network used by its predecessor, MIDAS.

Redesign of ATCAL Attrition Algorithm for Military OR Problems in the Twenty-First Century

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This presentation discuss improvements that will be necessary in the widely-used ATCAL attrition algorithm for military operations research (OR) problems of the Twenty-First Century. The attrition-cal (ATCAL) methodology was developed by the U.S. Army Concepts Analysis Agency (CAA) in the early 1980s to assess ground-combat casualties in the Concepts Evaluation Model (CEM). It has been used in CEM for theater-level analyses since then and today also finds use in major joint-warfare models. However, the theoretical foundations of ATCAL have never been fully documented, and consequently its parameter-estimation and attrition algorithms have not been completely evaluated. Moreover, this lack of documentation (together with the novelty of its concepts) has led to a reluctance of most users of TACWAR to exercise its recently installed ATCAL option. Also, its full range of possible applications goes far beyond the assessment of ground-combat casualties in theater models, but lack of documentation has obscured this significant aspect (particularly its possible use of methodological basis for JWARS).

Thursday, 1030 - 1200

COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday, 1330-1500

Line of Sight and Perspective View Server for Windows NT

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High speed line-of-sight (LOS) and video realistic perspective view generation (PVG) are now available in low cost PC based hardware running Windows NT. Advances in disk capacity, execution speed, and symmetric multi-processing configurations allow scalable servers to be built which can provide LOS and PVG services in an interactive networked environment at low costs.

This paper presents algorithms and performance data on LOS and PVG functions executing in one to four Pentium Server systems. The ability of this system to support large scale exercises over large geographic areas will be analyzed. A one meter resolution terrain database used to support such calculations is discussed. Availability of existing data bases and production costs to build support data for new areas are presented.

Communications interfaces and HLA compliance in the first prototype system delivered in support of the Rotary Pilots Associate operational test at Yuma Proving grounds will conclude the presentation.

Achieving platform independence for network communications and user interfaces accessing the Generic Data System

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The proliferation of diverse computing platforms and operating systems throughout the Department of Defense and related organizations has increased the need to address portability issues for software system development.

The Generic Data System (GDS), developed at the Los Alamos National Laboratory, is a data distribution system designed to provide simulation information to client programs executing on the Solaris (SPARC and x86), DEC Unix, IRIX, and HP-UX operating systems. The GDS provides access to data from several simulation models including the Air Warfare Simulation Model (AWSIM), the Corps Battle Simulation (CBS), the Joint Theater level Simulation (JTLS), and the Research and Evaluation System for Analysis (RESA).

The introduction of the Java programming language several years ago brought with it the promise of platform independence. Java provides a very well defined specification that guarantees cross platform portability at the source code and execution level given that a Java Virtual Machine (JVM) is available on the target platform.

A platform independent network interface package (NIP) to the GDS has been implemented in the Java programming language. GDES client programs written in Java using the NIP can execute on any operating system having JVM implementations, which includes virtually all flavors of UNIX, Windows 95/NT, OS/2, and MacOS.

The design and implementation of the network interface package, the hurdles encountered during development, and the benefits associated with using Java for this effort will be presented.

C-17 Airlift Loading Model Using Java

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Theater-and campaign-level planning requires the ability to efficiently and accurately forecast the number of strategic airlift resources needed to transport personnel and equipment. However, the current Airlift Loading Model (ALM) and the Computer Aided Load Manifesting (CALM) model only account for one objective (improving cargo utilization), and do not consider prioritized cargo; handle odd-shaped cargo very well; guarantee balanced loads; or model hazardous cargo constraints. We introduce a more accurate formulation – the Airlift Loading Problem (ALP) – that accounts for these additional restrictions, then present a prototype solver for the ALP that is unique in two respects: (i) the use of a two-dimensional packing heuristic using simple tabu thresholding solutions; and (ii) implementing the heuristic with the Java programming language and its object-oriented structure.

Modeling Using Dynamic Network Algorithms

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Many military problems involve moving people, materials or both within the shortest time (quickest transshippment) or within a specified time (dynamic transshippment). Recently, an algorithm has been published by Bruce Hoppe to solve these problems in strongly polynomial time using dynamic networks. We are currently implementing this algorithm as one basic model underlying our network analysis for military applications.

The advantages to using dynamic flow networks are: (a) For multiple time periods, the network representation does not have to be networks. This means significantly less memory is required for networks that are handling multiple time periods; (b) The run-time is often used to model continuous time real-world problems, a polynomial solution time is desired as the granularity of the model increases; and (c) A better representation of the network is achieved since the traversal times of arcs are directly represented in the network and there is no need for intermediate nodes to be created.

Verification, Validation and Certification Process and Automated Tools

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Verification, Validation, and Certification (VV&C) of modeling and simulation data is an area that has always and will continue to be of concern to both the operations research analyst as well as organizations wanting to leverage data within and between organizations. Military operations research organizations will continue to strive for credible data using an VV&C process to provide a credible foundation for their studies and analyses. Because there requires at times large amounts of data to run models and simulations which includes the range of engagement to campaign data requirements, VV&C process and tools are sometimes needed to support the analyst in credible analyses.

The presentation will introduce the concepts of verification, validation and certification of data within a set of tools being developed to help automate this process; provide an overview of what VV&C linkage are necessary; and then expand the example to include a working model application. Future efforts are planned to expand and complete VV&C tools through V&V data visualization, pedigree data process, and certification of data.

WG 32 – SOCIAL SCIENCE METHODS – Agenda

Chair: Mr. Hugh A. L. Dempsey, TRADOC DCSR
Cochair: Denise Aleva, AL/CFHV
Cochair: Gilbert G. Kuperman, AL/CFHV
Cochair: Dr. Franklin L. Moses, USARI
Cochair: Dr. Jock O. Grynovicki, AMSRL-HR-SD
Advisor: Dr. James C. Geddie, MASRL-HR-MV

Room: ME-147

Tuesday, 1030-1200
A Framework for Assessing Value Added Of New Training Technologies
Richard E. Christ, PhD, U.S. Army Research Institute Office, John K. Hawley, PhD, Human Factors Consultant

What Is The Difference Between Defense Economics And Military Operations Research?

Gregory G. Hildebrandt, Naval Postgraduate School

Performance-Based Metrics to Assess Battlefield Visualization: Prairie Warrior 97 -- Maneuver Control System (MCS)

Dr. Jock O. Grynovicki, Kragg P. Kysor, Michael G. Golden, and Dr. Madeline B. Swann, Army Research Laboratory -- Human Research and Engineering Directorate

Comparison of Various Types of Head-Related Transfer functions for 3-D Sound in the Virtual Enrivonment

Douglas Savick, US Army Research Labs

Tuesday, 1330-1500
Subjective versus Performance-based Testing: The Best of Both Worlds

Chris Grounds and Dick Steinberg, Schafer Corporation.

Usability Testing of Input Devices in MOPP IV for THAAD

Chris Grounds and Dick Steinberg, Schafer Corporation

Defining the NMD C2 Operator Roles, Responsibilities, and Information Environment
Dr. Beverly G. Knapp
US Army Research Laboratory-Ft. Huachuca Field Element, Mr. Eric Barieau, System Technology Associates, Mrs. Carol Daniel, Schafer Corp

Understanding Political Instability through Dynamic Networks

Karen T. Parsons, International Relations Specialist, Michael L. Haxton, Operations Research Analyst, Joint Warfare Analysis Center

Wednesday, 0830-1000
Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling

Alan D. Zimm, Senior Professional Staff, Johns Hopkins University Applied Physics Laboratory

Forward Engagement Requirements for U.S. Naval Forces:New Analytical Approaches

CDR Ron Brown, Dr. Siriphong Lawphongpanich, Dr. Robert Looney, Dr. Daniel Moran, Dr. David Schrady, Dr. James Wirtz, Dr. David Yost, Naval Postgraduate School

Wednesday, 1030-1200
Estimating the Impact of Random Drug Testing

Dr. Jules I. Borack, Senior Scientist, Navy Personnel Research and Development Center

An Enlistment Bonus Allocation Model

MAJ Jeff Joles, MAJ Steve Charbonneau and Donald R. Barr, Operations Research Center, US Military Academy

The Application of System Dynamics Methodologies to Strategic Arms Control Policy

Mark D. Entner, Major, DLA Operations Research and Resource Analysis, Defense Supply Center

Wednesday, 1330-1500
Current Trends in Standardizing HCI Design in DoD Systems

Larry W. Avery, Pacific Northwest National Laboratory
A Object-Oriented Model of Task Workload and Information Processing in an Army Maneuver Battalion Tactical Operations Center

B. Diane Barnette and Sam E. Middlebrooks, Command and Control Modeling Office, Human Research and Engineering Directorate, Army Research Laboratory

Generation of Visualization Tools for Three-Dimensional Planing in a Joint Task Force (JTF) Scenario

Mr. Michael J. Barnes, US Army Research Laboratory-Ft. Huachuca Field Element
Theodore Fichtl (COL, Ret), The Compass Foundation, Inc., Ms Marsha McLean

Thursday, 0830-1000
"Quantification of Cognitive Process Degradation while Mobile, Attributable to the Environmental Stressors Endurance, Vibration, and Noise"

Salvatore P. Schipani, U.S. Army Research Laboratory

Development of Improved Performance Research Integration Tool (IMPRINT) Performance Degradation Factors for the Air Warrior Program

Lucia Salvi, Army Research Laboratory Human Research & Engineering Directorate

Poor or Nonexistent Requirements: A Danger to Our Customers, a Threat to Our Profession and a Recommended Strategy to Correct the Problem

Mack McKinney, Northrop Grumman, PO Box 17320, Baltimore, MD 21203, Phone: (410) 765-1097, FAX: (410) 993-2417

Soldier Performance on Various Terrain

Mr. Philip Crowell and Ms. Andrea Krausman, U.S. Army Research Laboratory , Human Research and Engineering Directorate

Thursday, 1030-1200
COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday, 1330-1500
Performance-Based Metrics to Assess the Effects of Digitization during the DIVISION XXI Advanced War-fighting Experiment (DAWE XXI)

Mr. Michael G. Golden, Dr. Jock O. Grynovicki, and Kragg P. Kysor, Army Research Laboratory -- Human Research and Engineering Directorate, Performance Metrics Team, Aberdeen Proving Ground, MD 21005

Pursuing Techniques to Support the 21st Century Warrior

Dr. Alfred G. Brandstein, Senior Analyst, Dr. Gary E. Horne, Scientific Analyst Marine Corps Combat Development Command

Modeling Complex Human Behavior Using Team-In-The-Loop Simulation

Douglas Macpherson, Research Psychologist, U.S. Army Research Institute for the Behavioral and Social Sciences

WG 32 - SOCIAL SCIENCE METHODS – Abstracts
Room: ME-147

Tuesday, 1030-1200
A Framework for Assessing Value Added Of New Training Technologies

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Information Age systems have high performance potential, but the training necessary to realize this potential is often difficult or impossible to conduct using conventional training methods. Furthermore, many new high-technology training methods are still in their infancy and it remains to be unambiguously demonstrated whether they can deliver on their up-front promises. The issue of incremental benefit is often referred to as the value added problem. In the proposed presentation we will provide a definition of value added, contrast value added with cost effectiveness, and describe a methodology for assessing value added that addresses the following hierarchy of questions. (a) Is the potential training application suitable for the technology in question? (b) Is the training application effective in improving performance of the required skill repertoire in the target population? (c) Is the potential application superior to conventional training methods? (d) Is the demonstrated training superiority operationally relevant to mission success? The case for a potential training application having value added is strengthened as the question defining each level of the hierarchy is answered in the affirmative. We will describe approaches designed to answer each question, running the gamut from a thorough front-end analysis, through a series of well-designed simulated or actual training exercises, to multiple runs through combat simulation models, and where the empirical training effectiveness measures are often derived from *quasi experiments*. This value added framework will be discussed in the context of a new multi-Service distributed interactive training simulation testbed.

What Is The Difference Between Defense Economics And Military Operations Research?

Gregory G. Hildebrandt, Naval Postgraduate School

Using illustrations from defense analysis, a brief overview of the history of economics and operations research since World War II will be provided. This discussion will help formulate several hypotheses concerning the similarities between economics and operations research as academic disciplines and policy analysis tools. The first hypothesis relates to the distinctions among explanation, prediction, and control: Economics is to physics as operations research is to engineering. The second hypothesis relates to the emphasis given each discipline in its applications: Economics emphasizes demand; operations research emphasizes supply. The third hypothesis relates to the types of models used in the two disciplines: Economic models are intellectual constructs (ideal types); operations research models are (slight) simplifications of reality. The fourth hypothesis reflects a recent trend: Economics has taken a rationalist turn; operations research has taken an empiricist turn. While we show that there is some validity to these hypotheses, which supports the view that the disciplines are complementary, reality is far more complex. Each hypothesis, therefore, generates several sub-hypotheses which amplify and refine the basic question.

A concrete illustration of several differences between the disciplines will be provided using an analysis of aircraft maintenance. An OR model which obtains technological efficiency will be described; response surface methodology will be employed to obtain the production function that is an aid to achieving economic efficiency; and the cost function that assumes economic efficiency will be derived.

Performance-Based Metrics to Assess Battlefield Visualization: Prairie Warrior 97 -- Maneuver Control System (MCS)

Dr. Jock O. Grynovicki, Kragg P. Kysor, Michael G. Golden, and Dr. Madeline B. Swann, Army Research Laboratory -- Human Research and Engineering Directorate, Aberdeen Proving Ground, MD 21005

One of the U.S. Army Research Laboratory's (ARL's) Science and Technology Objectives (STO) research projects is to develop standardized field-operational soldier performance metrics to quantify integrated soldier-information system performance on the digital battlefield. This research effort is intended to help the Army leadership assess the impact of digitization on individual soldier and staff performance. These measurement scales directly support the Joint Venture Axis Five and Seven and Rolling Baseline Assessment of digital information system technology during Advanced Technology Demonstrations, Advanced War-fighting Experiments, and related Force XXI and Army-After-Next field activities.

In conjunction with this project, ARL supported the Battle Command Battle Laboratory (BCBL) and the Operations Test and Evaluation Command (OPTEC) in studying Battlefield Visualization issues during the Prairie Warrior 1997 exercise (PW 97). The focus of ARL's study was on the Maneuver Control System (MCS) battlefield operation system (BOS) software that was designed to enhance the Mobile Strike Force (MSF) soldier and staff performance during the exercise by providing a clear understanding of the current state of a battlefield situation with relation to the enemy and environment.

The paper specifically describes efforts to define and measure soldier MCS information functionality and usability. The report includes lessons learned from PW 97 and describes how the evaluation methods and metrics were developed and improved to produce an evaluation package that can be used in other Advanced War-fighting Experiments (AWEs), Command Post Exercises (CPXs), and simulation exercises. Results of the behaviorally-anchored rating scale (BARS) and usability index administered to the MSF during the PW 97 exercise are presented.

Key Words: Prairie Warrior 97, Maneuver Control System (MCS), performance metrics, behaviorally-anchored rating scales (BARS), soldier system interface, graphics user interface (GUI)

Comparison of Various Types of Head-Related Transfer functions for 3-D Sound in the Virtual Enrivonment

Douglas Savick, US Army Research Labs

Simulation using virtual reality (VR) is becoming an effective tool for the Army in training soldiers to do their required tasks. In VR, the human operator can interact with a wide variety of computer-generated worlds developed from real or imaginary scenarios, or both. The training that a soldier receives by simulation is usually cost effective to the Army and, in a number of cases, safer for the individual than training in the real environment.

Complete immersion of an individual in the virtual environment (VE) is difficult to accomplish. Currently, no VR system can fully simulate all areas of a real environment that affect all five senses of the human. However, in the past few years, major advancements have been made in simulating signals that affect the human senses. One such advancement is the use of three-dimensional (3-D) sound in the VE. Individuals hear sounds in their natural environment from every direction in 3-D space and the untrained ear can determine the sound source's direction within a 10° error of accuracy.[1] 3-D sound in the VE provides a more realistic simulation of acoustic environments compared to diotic (mono) or dichotic (stereo) sound presentation. The major benefit of using 3-D sound is that an individual can determine the sound source direction. By providing sounds that are perceived to have direction and sights representing virtual objects that produce the sounds through a head-mounted display (HMD), a person can monitor and identify sources of information from all possible locations.

Producing localized sound is a complex process. Sounds produced in the real world are perceived from a certain location, based on intensity and time differences between the ears and the spectral shaping by the individual's pinnae (outer ear)[1]. Specifically, the outer ear acts as a direction-dependent sound filter to aid the listener for "pin-pointing" sounds. A mathematical representation of the filtering characteristics of the pinnae is provided by the head-related transfer function (HRTF): "the complex valued free-field transfer function from a sound source in a certain direction to the eardrum".[2] The HRTF can be developed by recording a generated broadband sound using a probe microphone in the ear canal and subsequently dividing the Fourier transform of the recorded sound by that of the generated sound. Using digital filtering techniques, HRTFs can be applied to sounds through headphones. By filtering an arbitrary sound with HRTF-based filters, the sound should appear to come from specified virtual locations outside of earphones. Ideally, every person should have his or her own unique or "matched" HRTFs to generate localized sound. Because the development of matched HRTFs is time consuming, generic or "unmatched," HRTFs are used to satisfy a broad range of listeners.

The purpose of the study was to determine if 3-D sound generated by a Tucker-Davis Technologies 3-D sound system can enhance the "realism" or fidelity of the VE used in the I-Port program. The main objective of the study is to determine if an individual can distinguish the direction of a sound source within a reasonable degree of accuracy. The study featured a comparison between using matched HRTFs versus generic HRTFs.

Tuesday, 1330-1500

Subjective versus Performance-based Testing: The Best of Both Worlds

Chris Grounds and Dick Steinberg, Schafer Corporation, 1500 Perimeter Parkway, Huntsville, AL 35806, (205) 721-9572.

Real-time displays are dependent upon time to perform a task and errors in performing it. In an air defense setting, time and error rates are critical. Taking too long to perform a task, or performing it incorrectly, can result in catastrophic losses. In many performance-based user assessments, alternative prototypes for user interfaces are statistically proven to be significantly better than others. However, in others, there are no clear winning prototypes. Often, sometimes the soldiers will prefer one prototype while performing faster on another. Factors that may heavily influence preference may have the reverse effect on performance. Soldier performance is usually the critical measure in determining optimal formats for real time or near real time interfaces. Soldier preference may or may not agree with the performance results. The Brown-Gibson Approach to multi-attribute decision making allows for both viewpoints (preference and performance) to be factored into choosing the best alternative. Statistical based usability tests for displaying incoming hostile tracks were performed by sixteen soldiers using alternative prototypes for the Theater High altitude Area Defense (THAAD) Battle Management Soldier User Interface. Using the Brown-Gibson model for multi-attribute decision making, the amount of subjective and objective weighting can be used to make a decision on which alternative would be best for the soldier.

Usability Testing of Input Devices in MOPP IV for THAAD

Chris Grounds and Dick Steinberg, Schafer Corporation, 1500 Perimeter Parkway, Huntsville, AL 35806, (205) 721-9572.

1Wenzel, E. M. (1992). Localization in Virtual Acoustic Displays. Presence: Teleoperators and Virtual Environments, 1, 80-107.
2Brontehorst, A.W. (1995). Localization of Real and Virtual Sound Sources. Journal of the Acoustical Society of America, 98(5), 2542-2553.

Modernizing workstations for military applications is a challenge: designers must increase performance without affecting safety in any way. Furthermore, interaction efficiency is required to avoid fatigue and minimize error rates which could cost lives. This is complicated by the fact that warfighters at times, are required to operate the interface wearing Mission Oriented Protective Posture (MOPP) Gear. Statistical based usability tests were performed with soldiers to determine optimal input devices for display designs for the U. S. Army's Theater High Altitude Area Defense (THAAD) Soldier User Interface. THAAD prototype formats using windowing environments were tested to compare input devices using fifteen soldiers from the U. S. Army Fort Bliss 1/6 ADA Battalion. Research has shown that soldier performance while wearing MOPP IV clothing is degraded. Input devices were tested under nominal clothing and with MOPP IV protective clothing. Methods and input devices for minimizing the amount of performance degradation on a Soldier computer Interface while wearing MOPP IV clothing were identified.

Defining the NMD C2 Operator Roles, Responsibilities, and Information Environment

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This effort is part of an ongoing analysis activity initiated by the National Missile Defense-Joint Project Office Battle Management/Command, Control, and Communications (NMD-JPO BM/C3) office to define and model new C2 operator roles, responsibilities, and informational needs for a system with no immediate predecessors. Consensus in the NMD operational community is that NMD C2 functions will be shaped using existing missile warning, space surveillance, and ground air defense systems as a point of departure. However, system developers for NMD BM/C3 suggest that this new system will be a highly sophisticated, largely automated defensive capability that will revolutionize traditional human operator roles. Knowledge elicitation focus groups leading to the development of a constructive NMD C2 simulation were the analysis approach used to address these concerns.

First, two focus groups were held where candidate operator functions, task flows, and informational requirements were elicited from NMD subject matter experts, using cognitive task analysis scaling methods, including unconstrained card sorting and consensus building exercises to establish a baseline. Next, a decision tree analysis was conducted to begin clustering task groups with information items. Data from these group sessions were then used to begin construction of a computer-based simulation to examine trade-offs. A first generation simulation using the MicroSaint human performance modeling tool has been developed and is currently undergoing initial review.

Understanding Political Instability through Dynamic Networks

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Approved abstract unavailable at printing.

Wednesday, 0830-1000

Modeling Maneuver Warfare: Incorporating Human Factors and Decisionmaking in Combat Modeling

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Most current models of combat are based on an attrition warfare paradigm, where destruction of enemy forces and material are the objectives. However, models based on attrition warfare approaches do not reflect the actual combat processes that lead to victory. The current U.S. Marine Corps doctrine of Maneuver Warfare recognizes that the path to victory lies in more than destruction of material - for example, Marine Corps Doctrine Publication -1, "Warfighting," says that "the results of maneuver are both physical and morale. The object of maneuver is to shatter the enemy's cohesion, organization, command, and psychological balance." Clearly, any model that does not incorporate "cohesion, organization, command, and psychological balance" cannot reflect the relative strengths and weaknesses of Maneuver Warfare.

A serious handicap has been the lack of a conceptual model of Maneuver Warfare on a level that could be incorporated into computer simulations. This presentation outlines a conceptual model of Maneuver Warfare. The scope of the model runs from non-combat "deterrence" operations through combat in major wars. It incorporates defining and modeling the sources of victory, incorporates human factors such as morale, cohesion, and fighting spirit, and creates a conceptual model of the degradation of command processes when under stress. The objective is to provide a common taxonomy, define interrelationships, and serve as a springboard towards a more detailed algorithmic-level development of a model of Maneuver Warfare.

Forward Engagement Requirements for U.S. Naval Forces:New Analytical Approaches

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This study develops new analytical approaches to defining and articulating requirements for forward-engaged naval forces. It consists of two interrelated tasks. The first is an analysis of economic benefits generated by forward engaged naval forces. In general, the cost of forward engagement is better understood than the economic benefits resulting from it. This study addresses the benefits side of the issue, as illustrated by the reaction of oil markets to naval crisis response during three recent Persian Gulf Crises. The value of naval forces is estimated by linking naval crisis response to fluctuations in oil futures prices. Oil price data then serves as input for an econometric model that calculates key measures of economic performance; it is these indicators that allow economic benefits provided by naval forward engagement to be estimated.

The second task follows from the unpredictability of need, in time and place, for forward engaged naval forces and the resulting requirement for a robust forward engagement capability. An optimization-based model is used to schedule carrier deployments so as to maximize coverage of forward areas and minimize response times. Force structure can thus be linked to crisis response times and which allows further linkage to the economic models used to measure economic benefits of naval forward presence. Such links facilitate sensitivity analysis regarding the economic value of various levels of naval force structure. Conservative estimates indicate that the economic benefits of naval forward engagement in the Persian Gulf region far outweigh the cost of maintaining it.

Wednesday, 1030-1200

Estimating the Impact of Random Drug Testing

Dr. Jules I. Borack, Senior Scientist, Navy Personnel Research and Development Center, 53335 Ryne Road, San Diego, CA 92152-7250, Phone (619) 553-7641, FAX: (619) 553-7925, email: borack@nprdc.navy.mil

The Navy's zero-tolerance drug policy has been in effect since 1981. Since then the Navy has pursued an aggressive urinalysis-testing program. The objectives of the program have been to deter and detect drug abuse, as well as to provide data on the prevalence of drug abuse. The program has been considered successful; the proportion of sampled service members testing positive for drugs has fallen from approximately 7% in 1983 to less than 1% in recent years.

This research has developed a procedure for estimating the impact of alternative random drug testing strategies on reducing Navy drug use. Test strategies can vary in their monthly test rates, test sensitivities, and random selection schemes. The costs of a testing program can include laboratory costs, the lost-time of personnel undergoing testing, and the costs (recruiting, training, discharge, etc.) of replacing detected personnel. Drug users may vary in the type and frequency of drug, and in 'gaming' strategy. The approach integrates a variety of methodologies including probability, statistics, survey sampling, optimization, and economics in order to develop a model for estimating detection and deterrence effects, and costs and benefits of testing. The monthly test rate, sensitivity of the test to previous drug use, frequency of drug use, and other factors all impact the probability of detecting and deterring drug users. Changes in these parameters can exert a profound impact on deterrence effect of testing, as well as the expected time until detection.

An Enlistment Bonus Allocation Model

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The US Army Recruiting Command (USAREC) has completed a survey of potential recruits, using a market research approach known as "choice-based conjoint analysis." One product of this work is a set of utilities that can be used to estimate relative proportions of the target population that would choose each of certain offered incentive packages. Incentives considered include bonus awards, length of commitment, military occupational specialty (MOS) and payment of college loans. We report results of a study sponsored by USAREC aimed at exploiting utilities from conjoint analysis to optimally determine the Army's recruiting bonus structure. We demonstrate use of integer programming techniques to determine optimal bonus "packages" for a set of MOS categories and present an example suggesting the feasibility of this approach.

The Application of System Dynamics Methodologies to Strategic Arms Control Policy

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This paper discusses the application of the system dynamics approach to the problem of arms control. The system dynamics approach is a relatively new technique for the operations research community. This approach enables the researcher to capture the dynamic nature of complex systems that involve feedback such as the interaction of multiple players in a political domain. To begin the paper will give a brief introduction to the system dynamics approach. The paper will then present a model and simulation of the arms race between the former Soviet Union and the United States. After the historical example, a general model of a multi-player conflict will be developed and then expanded to illustrate how system dynamics can be used by the researcher and decision maker to model, simulate, and conduct policy analysis in the arms control environment.

Wednesday, 1330-1500

Current Trends in Standardizing HCI Design in DoD Systems

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Standardization of human-computer interface (HCI) design within the Department of Defense (DoD) has been a long term goal for all the services. There are a number of on-going efforts to facilitate this standardization through the development and implementation of HCI design standards and style guides. At the DoD level, two of the major documents that govern HCI design are the DoD HCI Style Guide (Volume 8 of the Technical Architecture Framework for Information Management) and the User Interface Specification for the Defense Information Infrastructure (DII). There are additional joint efforts toward developing standard guidance, including the development of a aviation joint service specification.

Each of the services have tailored the DoD level guidance and developed their own style guides and guidance documents. The Army has addressed real-time weapon system requirements, which differ from that of command and control (C2) systems, through the development of the Army Weapon System HCI Style Guide. The Army is also in the process of developing their HCI specification for the Army Battlefield Command System (ABCS). The Navy has produced a number of documents including the CS FAB Style Guide, while Airforce documents include the TBM HCI Specification for C2 systems. Each of these documents, while seeking to address the needs of the designers across the DoD, within a service, and within domains in each service, have their own uniqueness and usefulness. Designers need to be aware of the documents that are relevant to their system, as well as their appropriate uses.

A Object-Oriented Model of Task Workload and Information Processing in an Army Maneuver Battalion Tactical Operations Center

B. Diane Barnette and Sam E. Middlebrooks, Command and Control Modeling Office, Human Research and Engineering Directorate, Army Research Laboratory

Over the last three years, the Human Research and Engineering Directorate (HRED) of the Army Research Laboratory (ARL) has been performing task workload and information processing modeling of an Army Tactical Operations Center (TOC). This has, to date, been represented with hierarchical modeling constructs. Further, the TOC types and sizes have been limited to a maneuver battalion echelon, and comprised of no more than 24 people. Future modeling efforts are being focused on developing models of multiple battalions at the brigade level. Feeling that the hierarchical modeling approach would at some point become too restrictive, a decision was made to move current, and future, models into a more flexible and efficient object-oriented simulation and modeling language.

Current workload values supplied to the model have been developed from an extensive HRED research project. In consonance with model development, the Job Assessment System Software (JASS) tool, also developed by HRED personnel, has been modified for data collection from expert military personnel with prior experience in performing command and control operations. JASS systematically queries the user about the perceived workload, in relation to all the tasks performed in the TOC by that person, rated on a scale from one to seven for each task performed. As the database of those actual workload values becomes available, the subjective data initially supplied to the model will be replaced.

In addition, plans are to build 'hooks' into newly developed models that facilitate the interface of the task workload and information processing models to the HRED Intelligence Production Model (IPM). This will provide a quantitative measure of the use of information that comes into the TOC. Future modeling efforts will also focus on the interface of an external model to assess the quality of the cognitive processing activities of the TOC personnel as they proceed through command and control operations.

This paper describes the transition process of moving from a hierarchical architecture to an object-oriented environment, new representations of entities, classes, attributes, and functions, and database development using JASS. Further, future considerations for higher echelon models will be discussed.

Generation of Visualization Tools for Three-Dimensional Planing in a Joint Task Force (JTF) Scenario

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With the advent of modern computer technology, future commanders and staff will be able to visualize multiple perspectives of their battlespaces as well as to examine the consequences of multiple courses-of-action (COA). The purpose of our program was to develop visualization concepts that were visionary, operationally appropriate, and useful for rapid deployment. We used rapid prototyping, various knowledge elicitation methods, and computerized evaluation tools to generate and assess various concepts. Our greatest challenge was to capture the diversity of the joint task force planing environment while eliciting concepts that were both creative and technologically feasible. Three data collection efforts were conducted. The first effort focused on 12 officers from the Army War College chosen for expertise in joint planning. Based on their requirement's analysis, we rapidly prototyped 35 visualization concepts on Silicon-Graphics equipment (R-4000). The concepts were three-dimensional renderings portraying targeting, flight management intelligence, and collection management functions in a JTF environment contrasting various innovative visualization candidates.

Two additional elicitation sessions were done at Ft. Huachuca, AZ and at the Naval Research and Development Center (NRAD) in San Diego, CA. For these sessions, we used a computerized evaluation tool package called Group Systems developed by the University of Arizona. With the JTF scenario as a backdrop, we presented each visualization concept and allowed the participants to comment and dialogue among themselves using the computerized tools before ranking and evaluating the individual concepts. The results were a prioritization of the concepts based on multiple criteria as well as the generation of new visualization and information concepts. We are in the process of consolidating the concepts, suggesting decision support augmentation, and writing the top level specifications for an animated visualization package to be housed in a laptop environment. The Army Research Laboratory's future research efforts include combining visualization with intelligent systems to allow the commander not only to evaluate alternative COAs but to be able to visualize the consequences of the generated computer options.

Thursday, 0830-1000
"Quantification of Cognitive Process Degradation while Mobile, Attributable to the Environmental Stressors Endurance, Vibration, and Noise"

Salvatore P. Schipani, U.S. Army Research Laboratory

The objective of this exercise was to quantify operator cognitive performance in an off-road environment, by repeatedly administering a battery of cognitive measures to assess the genus and degree of performance while moving. As experimental conditions were executed, environmental stressors referred to as *endurance* (measured as time in the environment), tracked vehicle *vibration* per intensity (collecting absorbed power measures and by comparison with exposure limit criteria), and *noise* (in dBa) were recorded over the course of one day per test participant (n=18). Vibratory conditions presented were varying amplitudes approximating accelerations of 0.88 g by a frequency of 3 cycles per second traveling 20 miles per hour, 0.65 g by 4 cps at 10 mph, and 0.03 g by 12.5 cps at 0 mph.

The cognitive concepts observed were *selective attention, inductive reasoning, time sharing, memorization, spatial orientation*, and *speed of closure*. Psychometrics chosen to evaluate these were, respectively, the "Continuous Recall" task, the "Mathematical Processing" task, the "Grammatical Reasoning" task, and "Sternberg's Memory Search" (from the 'Criterion Task Set'), and the "Route Planning" and "Missing

Items" tests (from the 'Complex Cognitive Assessment Battery'). Perceived stress was also assessed using an ARL (HRED) modified stress battery, which includes an Amylase enzyme assay.

Observed collectively, the predictor variables returned a multiple R value for the dependent variable percent correct of 0.733 ($p < .0001$) and for the dependent time to complete of 0.649 ($p < .0001$). Although all stressors significantly influenced performance, uncovered was a repeated order of effect per evaluation method beginning with the measure *endurance* exhibiting most influential effect, then *session,* this followed by *absorbed power* recordings, next *exposure limit* criteria comparison, and finally *noise.*

Results revealed the tests selected as capable of measuring their associated concept. Cognitive performance decrement, measured as percent correct of test scores, was found greatest for the concept *time sharing* (a 46% decrease from baseline), next greatest influences were found for *selective attention* (a 37% decrease) and *inductive reasoning* (also a 37% decrease), followed closely by *spatial orientation* (a 36% decrease), then *speed of closure* (a 34% decrease), and finally *memorization* (a 21% decrease from baseline, degrading the least). Measured as percent of time taken to complete tests, degradation was found greatest for the concept *speed of closure* (an increase of 40% in time taken to complete test), the next greatest influence on *time sharing* (a 27% increase), followed by *inductive reasoning* (a 24% increase) and closely by *spatial orientation* (a 23% increase), then *selective attention* (a 21% increase), with *memorization* once again least (a 7% increase in time from baseline).

This investigation also displayed the existence of dose response relationships, higher doses of vibration associated with more unfavorable effects. Additionally, the trials effect recorded indicate that performance deteriorated as a function of time in the environment, and did so consistently by the fourth hour of operation. The trend of the data suggests that had testing continued for a longer period of time, the trials effect would have been greater.

Development of Improved Performance Research Integration Tool (IMPRINT) Performance Degradation Factors for the Air Warrior Program

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Through the years, Army aviators have acquired and adapted Clothing and Individual Equipment (CIE) and Aircrew Life Support Equipment (ALSE) that are used for both routine and mission-specific scenarios. Historically, these items were developed by various organizations to meet specific requirements such as fire retardation, protection from weather, or protection from chemical environments. Sometimes these items work well individually, but because they were not designed to work as a system, they fall short in terms of working as a fully integrated set.

In one of four related efforts, the Human Research & Engineering Directorate of the U.S. Army Research Laboratory was tasked by the Program Manager for Air Warrior to examine the effects of CIE and ALSE on the mission performance of Army aviators. These effects were quantified in terms of the additional time needed to perform certain types of tasks as a direct result of the equipment items. Estimates of the increased time to perform were solicited from subject matter experts through completion of a detailed questionnaire. These questionnaires were administered to groups of Army aircrew throughout the country.

Time estimates were then compiled and analyzed and a set of performance degradation factors were developed. These performance degradation factors were then used to preprocess task data for the task network modeling tool Improved Performance Research Integration Tool (IMPRINT) to predict the effects of CIE and ALSE on mission and system level performance through detailed computer modeling. This methodology will facilitate future comparison and evaluation of proposed equipment configurations.

Poor or Nonexistent Requirements: A Danger to Our Customers, a Threat to Our Profession and a Recommended Strategy to Correct the Problem

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Approved abstract unavailable at printing.

Soldier Performance on Various Terrain

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The dismounted soldier must adapt to the changing nature of battlefield conditions (i.e climatic conditions, terrain, operational tempo etc.) while successfully performing tasks necessary for each scenario. Each of these demands place both a physical and cognitive load on the soldier. The majority of research in this area has concentrated on quantifying physical workload, few studies have addressed the effects of both physiological energy cost and mental workload (decision making, task time) on soldier performance. This research can be used to feed prediction models and arrive at a more realistic forecast of performance across terrain with other variables such as load, pace, and cognitive performance. Current models do not account for changes in cognitive performance as a function of physical workload. The objective of this research is to examine the physical workload of a soldier on various terrain and determine the effect on cognitive performance. An Oxylog® will be used to measure energy cost as a soldier walks on a paved surface, sand, slippery mud, and mud with tracked vehicle marks. A vigilance task and cognitive task will be used to measure mental workload. The soldier will carry two different loads, fighting load, and approach march load. One pace will be used across each of the terrain conditions. Results will be presented and discussed.

Thursday, 1030-1200

COMPOSITE GROUP G SESSION.. ME Auditorium

Thursday, 1330-1500

Performance-Based Metrics to Assess the Effects of Digitization during the DIVISION XXI Advanced War-fighting Experiment (DAWE XXI)

Mr. Michael G. Golden, Dr. Jock O. Grynovicki, and Kragg P. Kysor, Army Research Laboratory -- Human Research and Engineering Directorate, Performance Metrics Team, Aberdeen Proving Ground, MD 21005

As the lead agency responsible for the Division Advanced War-fighting Experiment (DAWE) Human Factors (HF) Issue, the U.S. Army Research Laboratory (ARL) developed two HF instruments to assess the impact of digitization on soldier and staff performance during the experiment. The first instrument (i.e., the "Usability Survey") was administered to all 4ID Advanced Tactical Command and Control System (ATCCS) operators and addressed ATTCS software interface usability. The second instrument (i.e., the "Functionality Survey") was administered to the 4ID Command Staff and selected Battlefield Operating System (BOS) cell Officers-in-Charge (OICs), and addressed Maneuver Control System(MCS) functionality as it supported critical staff tasks associated with decision-making and maneuver control. These two surveys were administered to the 4ID by the Test and Experimentation Command (TEXCOM) following the DAWE end of experiment (ENDEX).

The first ARL HF survey focused on the usability of the soldier system interface. The "usability" factor has a direct impact on staff performance because shortcomings in system usability lead to underlying error patterns, attentional fatigue, and excessive workload which can be linked to inappropriate decisions and priorities, serious delays in operational tempo, and failures in effective staff coordination and communications. The usability characteristics include whether the computer system contains simple and natural dialogue, speaks the user's language, minimizes user memory load, remains consistent between different modules and across applications, provides user feedback, provides clearly marked exits, provides process shortcuts, prevents errors, and whether its applications reflect doctrine. Additionally, questions regarding screen display variables such as screen layout, contrast, and symbology were also included in the survey.

Using the Department of Defense (DOD) Universal Joint Task List (UJTL) for command and control (C2) as a foundation, ARL's "Functionality Survey" focused on the interrelationship between the division staff functions or processes required for effective maneuver control and decision-making as supported by ATCCS software. ARL's survey metrics methodology evolved as part of an Army level Science and Technology Objective (STO) and established a cross-linking of FM 101-5 Decision Making Processes (DMP) with the MCS software modules believed to support critical command and staff task execution.

The paper specifically describes the methodology used to define and measure soldier and Staff performance.

Pursuing Techniques to Support the 21st Century Warrior

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Dr. Gary E. Horne, Scientific Analyst (horneg@quantico.usmc.mil)
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Recent changes in the analytical processes within the Marine Corps stem from the realization that traditional simulations were incapable of representing many of the attributes of the world required to help explore contemporary military issues. In addition analysts have observed that advances in computer science and calculational capabilities could, if applied properly, provide data and insight for more appropriate abstractions which would be useful in addressing many military questions. The result is a regression to the World War II roots of operations research. Namely, it is the use of multi-disciplinary teams and the scientific method. We want to take a look at questions of interest to the Marine Corps from the perspective of many data points. Our meta-technique, which we call data farming, provides a framework to explore questions in this manner. In our presentation we use agent-based models and map fitness landscapes to illustrate how we are beginning to implement data-farming on three fronts to support maneuver warriors: improving models, enhancing interpretation of results, and enabling intuition.

Modeling Complex Human Behavior Using Team-In-The-Loop Simulation

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The human component is essential for modeling complex battlefield systems. The human component adds flexibility to decisions and uncertainty to outcomes. It has been modeled since the 1960s. However now models have advanced to the level of requiring the modeling of multiple humans working together as teams. This presentation shows how analyses of team behavior can be obtained from battlefield models through the use of appropriate psychological constructs from cognitive and organizational disciplines. The specific data are from combined arms training exercises for teams of approximately twelve officers acting as brigade tactical commander, brigade staff, and battalion commanders/fire support officers using the JANUS computer simulation. The problem was to determine what indices of synchronized operations could be developed for use in the After Action Review (AAR) portion of training. The psychological constructs allowed the entities' behaviors captured in JANUS output files to be related to the doctrine and orders leading to them. This presentation demonstrates an approach to analyzing battlefield data that may help interpret the role of the complex human component.

Alphabetical Index of 66th MORSS Presenters

Prospective Attendees (as of May 20, 1998)

Adkins, MR Michael K - TRAC-OAC Analysis Center
Ainsworth, DR James S - Army Research Laboratory
Akst, DR George - MCCDC
Albert, MR Neil F - MCR, Inc
Alexander, MS Christi R - Institute for Defense Analyses
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Smock, MR Patrick G - US Army TRAC-FLVN
Smuck, MR John S - Naval Center for Cost Analysis
Snare, CPT Ross W. III - TRADOC Analysis Center
Snook, MS Ellen H - HQ TEXCOM
Snyder, Ms Cheryl Ann - BOEING
Sobel, LtCol Annette L - Sandia National Labs
Solick, MS Susan D - US Army TRAC
Soutter, LCDR Paul A - CNRC
Sowell, MR Jerry D - 68ECG/SF
Staniec, DR Cyrus J. - Logicon
Steinrauf, MAJ Robert L - CGSC
Stephens, MR Cortez D - ANSER
Sterle, MR Thomas J - Simulation Technologies, Inc
Stevens, MR Robert James - TRADOC
Stone, LTC George F III - TRADOC
Stone, MR Brice M - Metrica, Inc.
Stopkey, MAJ Stuart Waldemar - AFSAA
Stratton, MR Ray E - Lockheed Martin Corporation
Strycharz, Capt Theodore M - MCCDC
Sullivan, MR Timothy J - Raytheon Systems Company
Sullivan, Ms Patricia M. - USAE Waterways Experiment Station
Susman, Ms Chris - AMSAA
Swart, MR William R - Joint Command and Control Warfare Ctr
Swehosky, Dr. Frank J - Lockheed Martin Tactical Aircraft Systems
Swindell, MAJ Walter L II - USA Information Management Center
Sydla, Mr Michael J. - Mitretek Systems
Syring, LCDR Ronda J - Navy Recruiting Command
Szczepanek, MR Matthew J Jr - UNISYS
Szymanski, MR Paul S - Aegis Research Corporation
Taft, Mr Robert Lucien - NAVSURFWARCEN Dahlgren Division
Tatman, DR Joseph A - Litton TASC
Tatsumi, CPT Byron B - AFSAA/SAAD
Tatum, DR Boyd Charles - Navy Personnel R&D Center

Taylor, MR Charles B - ASD (C3I) Jiont C4ISR Decision Support Center
Taylor, Mr William W - RAND
Thomas, DR Robert William - Congressional Budget Office
Thomas, MR Clayton J FS - AFSAA/SAN
Thomas, Mr Steven Brent - RAND
Thomen, MR David S - SAIC
Thompson, MR George E - ANSER
Thompson, MR John R - SAIC
Thurman, CPT John L - ODCSPER
Thurman, LCDR Katie P. - COMNAVREDCOM REG22
Tillman, LTC Mark E - Joint Staff J-8
Timian, LTC Donald H - AMSO
Timmerman, Capt Thomas J - AFSAA/SAAG
Tsoucalas, MR Gregory A. - The MITRE Corporation
Tubridy, MS Lisa B. - Coastal Systems Station
Tucker, MR Dewey D - Computing Technologies, Inc.
Ullrich, Mr Thomas S - MITRE
Vacca-Leboeuf, MS Janet M - NAVY- Office of Special Projects
Valek, MR Raymond D - USSTRATCOM/J53
Vargas, MS Donna K - TRAC-WSMR
Vessey, MR Sean Donald - HQ Marine Corps
Vinarskai, MR James A - HQ HSC/XR
Visco, MR Eugene P FS - Consultant
Wagner, DR Michael - Dynamics Research Corporation
Walendy, Mr. John - The Boeing Company
Walker, Mr George Jay - Naval Health Research Center
Walker, Mr George Jay - Naval Health Research Center
Wallace, MR William J - The Boeing Company
Wallshein, MS Corinne C - AFSAA/SAAB
Walsh, LCDR Arthur C. - GG HQ Workforce Planning & Analysis
Walsh, MR John J - ODUSD (Personal & Readiness)
Waltensperger, MAJ George M - HQ AFOTEC/TSE
Walters, MR Charles E - The MITRE Corporation
Ward, LTDR Donald J. - OPNAV (NBI)
Ward, Mr David Jerome - Rolands & Asoociates Corporation
Warhola, Maj Paul J - OSD PA&E JWARS
Warner, DR Steve - Institute for Defense Analyses
Watrous, MR Frank T III - HQDA, ODCSPER
Webb, Capt Timothy J - HQ USAFA/DFMS
Weber, Ms Linda L. - The MITRE Corporation
Weeks, COL Edward D. - SAF/FMC
Weir, Capt Jeffery D - USSTRATCOM/J533
Wells, Capt. William David - CADRE/WGN
Westbrook, CDR Darrel E III - Operational Test and Evaluation Force
Wheeler, MS Joyce A - The Boeing Company
Whiteman, LCDR Philip S - USSTRATCOM/J533
Whitley, MR Howard G III - US Army Concepts Analysis Agency
Widdowson, CAPT Brian L. - USMC Studies & Analysis Division
Widdowson, CAPT Brian L. - USMC Studies & Analysis Division
Wiggins, MS Virginia L. - ASD (C3I) Joint C4ISR Decision Support Center
Wiles, MR Richard I - Military Operations Research Society
Wiley, Capt Victor D - AFMC Office of Aerospace Studies
Wilhelm, MAJ Scott Alan - AMLSAF
Wilkins, MR Lawrence B - ANSER
Williams, MR G Steven - Micro Analysis and Design, Inc.
Williams, Ms Laura - NPS
Willis, Mr Paul A - Whitney, Bradley and Brown
Wilmeth, MR James L III - SETA Corporation
Winant, MR Thomas C - United Defense LP
Wright, COL Sarah A - USAF WAR-MED Planning Systems Office
Wybenga, Mr Derk J - The Joint Staff, J-4
Wyman, MR Bruce D - ANSER
Yates, LtCol Thomas D. - CADRE/WGN
Yelverton, MR Robert F. Jr. - Sentel Corp/46 TS/OGEE
Yost, MAJ Kirk A. - Naval Postgraduate School
Young, MR David B - HQ AFOTEC/SAD
Zalewski, MAJ Daniel J - AFSAA/SAAS
Zandbergen, MR Wayne P - S3I
Zawada, LtCol Frank A - AFRL/VSSW
Zdyb, Mr Timothy Richard - Vector Research Incorporated
Zenker, MR Ernest G - Team Crusader UDLP
Zimm, MR Alan D - Johns Hopkins University/APL
Zmurkewycz, Ms Maria S - USAMSS
Zorn, Capt Wayne L - AFIWC/SAVA
Zouris, MR James M - Naval Health Research Center
Zucker, MS Andrea - Navy Recruiting Command
Zurey, CDR Mary J - COMOPTEVFOR (Code 41)
Zust, Mr Eric L - The BOEING Company

66TH MORSS AGENDA - NAVAL POSTGRADUATE SCHOOL		
Tuesday, 23 June 1998		
0700	0830	Registration
0715	0815	Composite Group/Working Group Chairs/Co-Chairs Warm-up
0830	1000	**PLENARY SESSION:** Keynote Speaker: Dr. William J. Perry, Stanford University (Former Secretary of Defense)
1030	1200	First Working Group **Session (#1)** COMPOSITE GROUP **A** & **D** SESSION
1200	1330	**Tutorials**
1330	1500	Second Working Group Session (#2) COMPOSITE GROUP **B** SESSION
1530	1700	**SPECIAL SESSION I** • "Leadership in an Information Dominant Battle" • "Mini-Symposium Reports: - "Complexity and Warfare Analysis" - "QDR Analysis – Lessons Learned and Future Directions" - "DoD Infrastructure – What it is & What does it cost?" • Prize Paper Presentations
1715	1900	Mixer/**Poster Session**
Wednesday, 24 June 1998		
0700	0800	Town Hall Meeting (CG/WG Chairs)/Editors' Breakfast
0830	1000	Third Working Group **Session (#3)** COMPOSITE GROUP **C** SESSION
1030	1200	Fourth Working Group **Session (#4)** COMPOSITE GROUP **C** SESSION
1200	1330	**Poster Session/Tutorials**
1330	1500	Fifth Working Group **Session (#5)** COMPOSITE GROUP **E** SESSION
1530	1700	**SPECIAL SESSION II** • "Validation Methodologies" • Mini-Symposium Report: *Simulation Technology (SIMTECH) 2007* • Junior/Senior Analysts Session
1930	2330	Monterey Bay Aquarium Tour and Strolling Dinner
Thursday, 25 June 1998		
0830	1000	Sixth Working Group **Session (#6)** COMPOSITE GROUP **F** SESSION
1030	1200	Seventh Working Group **Session (#7)** COMPOSITE GROUP **G** SESSION
1200	1330	**Tutorials**
1330	1500	Eighth Working Group **Session (#8)**
1500	1530	Composite Group/Working Group Chairs/Co-Chairs Wrap-up
1530	1700	**SPECIAL SESSION III** • Navy Flag Panel: "Preparing Today's OR Analysts for the Next Century" • Education Colloquium Session